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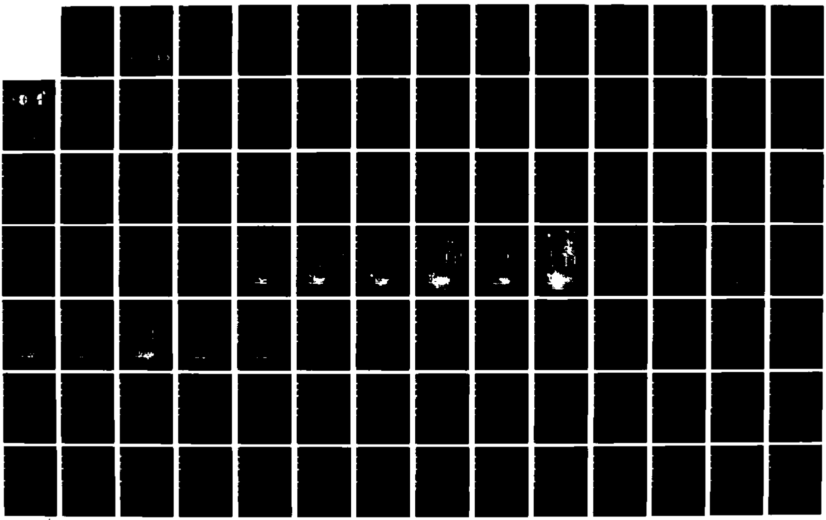

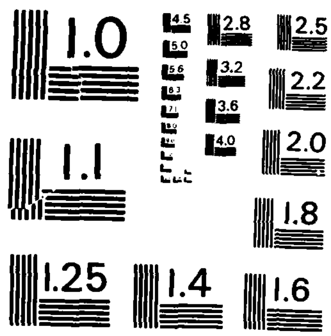

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Technical Report-85-E-3

AD-A163 561

VHF-FM COMMUNICATIONS ANTENNAS FOR PROJECT SINCGARS (UH-1 TAIL WHIP AND CABIN ROOF BENT WHIP EVALUATION)

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US ARMY AVIONICS R&D ACTIVITY

DECEMBER 1985

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19. ABSTRACT *(Continue on reverse if necessary and identify by block number)*

The American Electronics Laboratory (AEL), Allaire, NJ, was tasked by the U.S. Army Avionics Research and Development Laboratory (SAVAA-M), Fort Monmouth, NJ, to develop replacement breadband matching modules for the CU-942B and the FM 10-30-1 antenna to satisfy specified requirements for Project SINCGARS. AEL was further tasked to test various candidate antennas provided by commercial vendors that are mechanically interchangeable with the CU-942B and the FM 10-30-1.

After completion of the AEL development/test program, AVRADA tasked an independent, non-based Government antenna test facility to conduct prescribed antenna verification tests in accordance with an agreed upon test plan.

This technical report describes communications antenna systems provided by Dayton-Granger, Inc (DGI), American Electronics Lab (AEL), and Avionics Antenna Systems (AVANT). The test

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19. ABSTRACT (contd)

measurements were conducted at the Naval Air Development Center, Antenna Test Facility located in Warminster, PA.

The information in this report provides, in part, the technical data for the protection data package of adequate VHF-FM Communications antennas for the UH-1 helicopter when used with the new SINCGARS Radio.

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1. TEST OBJECTIVE

The object of this test was to evaluate three candidate antenna couplers, using different combinations of whip antennas, to determine which combination, if any, best meets specifications as a replacement for the U.S. Army's UH-1 Helicopter tail whip antenna. The present in-service coupler, with different whip antennas, was also tested.

2. TEST ITEMS

The Antenna couplers were evaluated in the following configurations:

MODEL	SERIAL NO.	MANUFACTURER	CONFIGURATION
CU-942B	00456	Comm Comp Corps	Standard AS-1703 whip antenna
CU-942B	00456	Comm Comp Corps	Dayton-Granger FM 11-22-7 whip
AV-1011	0001	Avant	Avant standard whip antenna
AV-1011	0001	Avant	Dayton-Granger FM 11-22-7 whip
FM 20-22-7	0012	Dayton-Granger	Dayton-Granger FM 11-22-6 whip
FM 20-22-7	0012	Dayton-Granger	Dayton-Granger FM 11-22-7 whip
AV 11-401B	0010	Avant	Avant AV 10-401B whip

Although not considered a part of the evaluation, the following couplers were also tested during different phases of the evaluation:

MODEL	SERIAL NO.	MANUFACTURER	CONFIGURATION
AO-1955	001	AEL	Standard AS-1703 whip
AO-1955	001	AEL	Dayton-Granger FM 11-22-7 whip
FM 10-22-6	002	Dayton-Granger	Dayton-Granger FM 11-22-6 whip
FM 10-22-6	002	Dayton-Granger	Dayton-Granger FM 11-22-7 whip
CU-942B	523	Comm Comp Corps	Standard AS-1703 whip

3. SPECIFICATIONS

The following specifications, as set forth by the U.S. Army, were used as a guide in the test evaluation:

Frequency Band:	30-88 MHz
Input Power:	50 Watts (5:1 Duty Cycle)
Antenna Gain:	Gain at 30 MHz no more than 9 dB below gain at 40 MHz
VSWR:	Less than 3.0:1
Average Gain:	Approximately -3 dB across the band
Gain Variation:	Less than 10 dB across the band

4. TEST FACILITY

The test measurements were conducted at the Naval Air Development Center Antenna Test Facility, located in Warminster, PA. The test measurements were made on two different test beds: a 32-foot ground plane and a full-scale UH-1 Helicopter.

a. 32-Foot Ground Plane. Absolute gain and Voltage Standing Wave Ratio (VSWR) were measured on the 32-foot ground plane shown in Figure 1. The mounting of the ground plane and the setup of the test range is shown in Figure 2.

b. Full-Scale Helicopter. Relative gain between test items and VSWR was measured on a full-scale UH-1 Helicopter which was transported to the test facility. The helicopter was placed on a 20- by 24-foot cement pad located 500 feet from Building 115. Figure 3 shows how the test range was set up for these measurements.

5. TEST CONFIGURATIONS

Different test measurement equipment configurations were used for the different measurements on the two test beds.

a. 32-Foot Ground Plane.

(1) Swept Frequency Gain Measurements. The test measurement equipment configuration for the 32-foot ground plane is shown in Figure 4. Swept frequency gain measurements were made using the direct comparison method. The Standard Gain Antenna (SGA) for this test was a 14.5-inch straight blade; Collins Model AS-3191/A. Its gain is directly traceable to tuned monopoles measured on the 31-foot ground plane.

For each measurement, the antenna coupler and the SGA were mounted on 1-foot square aluminum plates which were flush mounted in the center of the ground plane. Each of the test items were connected to the receiver through a 6-dB pad to insure a good impedance match. All tests were conducted with the leading edge of the test items facing the illuminating antenna and the ground plane tilted downward 20 degrees.

(2) VSWR Measurements. For the VSWR measurements, the test equipment was moved to the roof area and configured as shown in Figure 5. For these measurements, the SWR Autotester was connected to the device under test through a 4-foot length of RG-214/U coaxial cable.

b. Full-Scale Helicopter.

(1) Swept Frequency Gain Measurements. The couplers with their associated whip antennas were mounted on the helicopter in their normal flight location as shown in Figure 6. Swept frequency measurements were made from the front and right side of the helicopter.

The test measurement equipment was located in the equipment van and configured as shown in Figure 7. The swept frequency signals were transmitted from an APN-995B Log Periodic Antenna and received by the test items. The reference antenna was a CU-2331/A coupler with an AS-4085/A wide band whip mounted on a 4-foot ground plane.

(2) VSWR Measurements. The test equipment for the VSWR measurements on the helicopter was configured the same as for the ground plane (Fig. 5). Because of the height of the helicopter tail section, a 15-foot length of RG-214/U coaxial cable had to be used between the SWR Autotester and the device under test.

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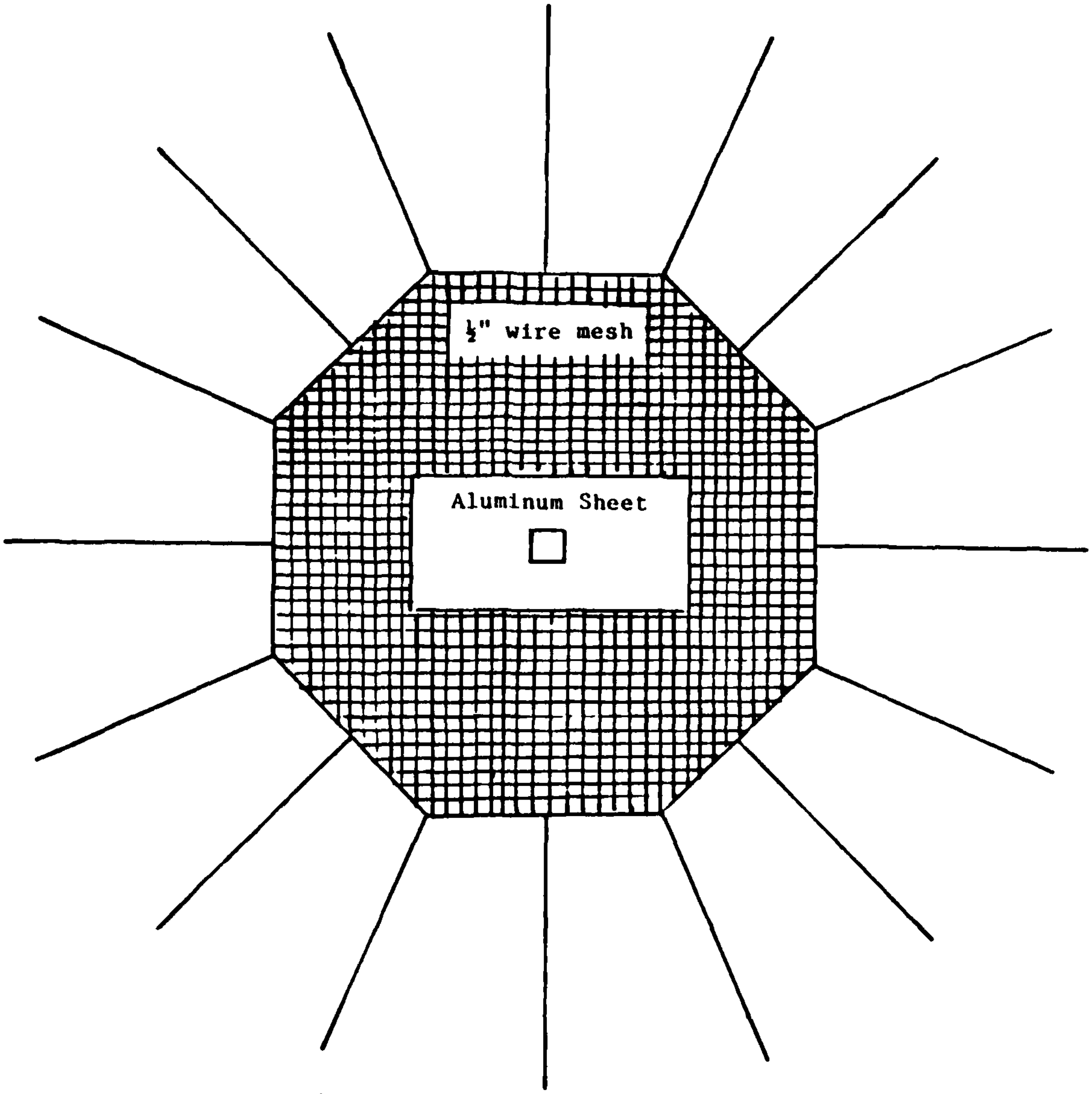

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Figure 1. 32-Foot Ground Plane.

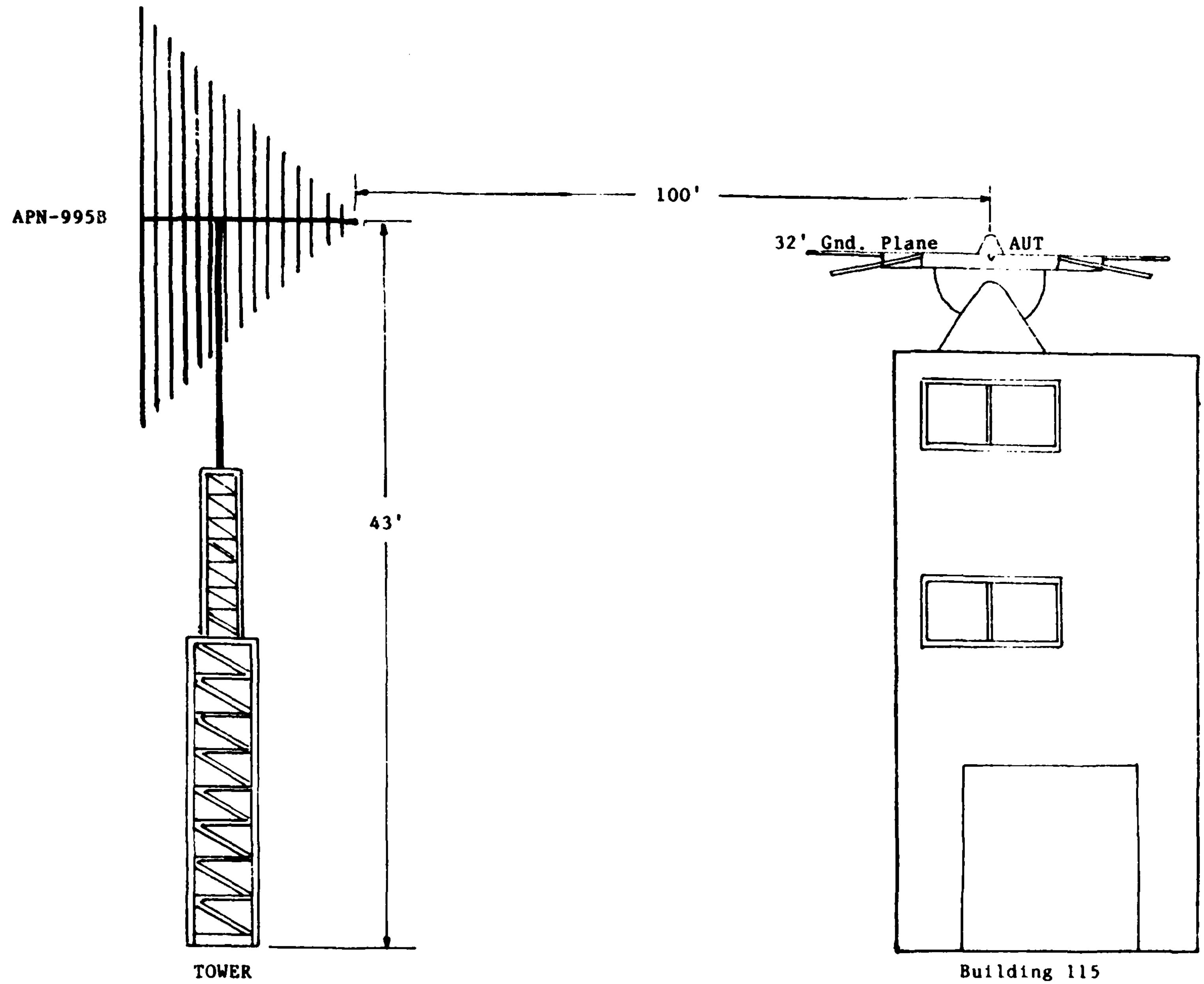

Figure 2. Ground Plane Range Setup.

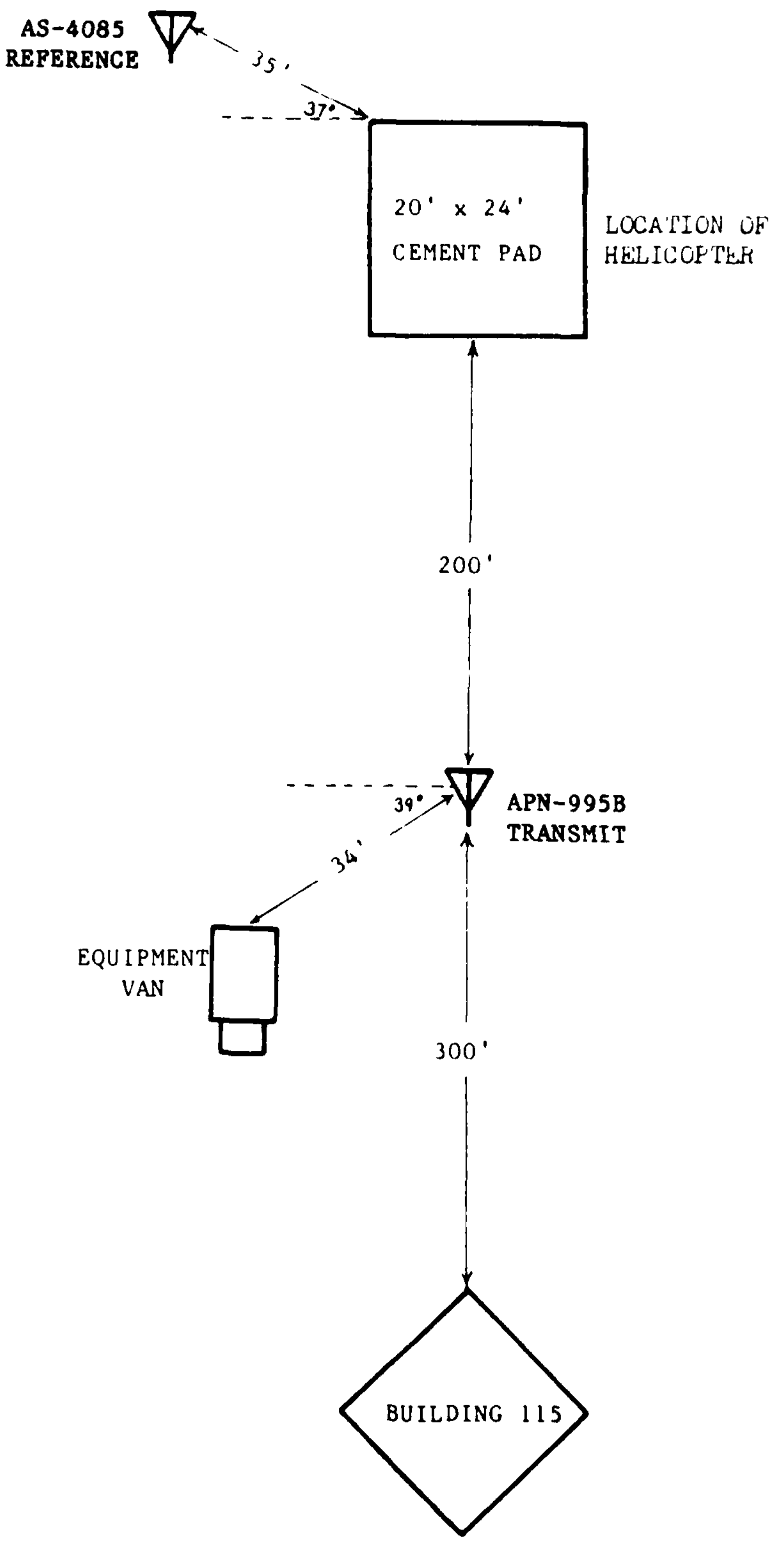

Figure 3. Test Range Setup.

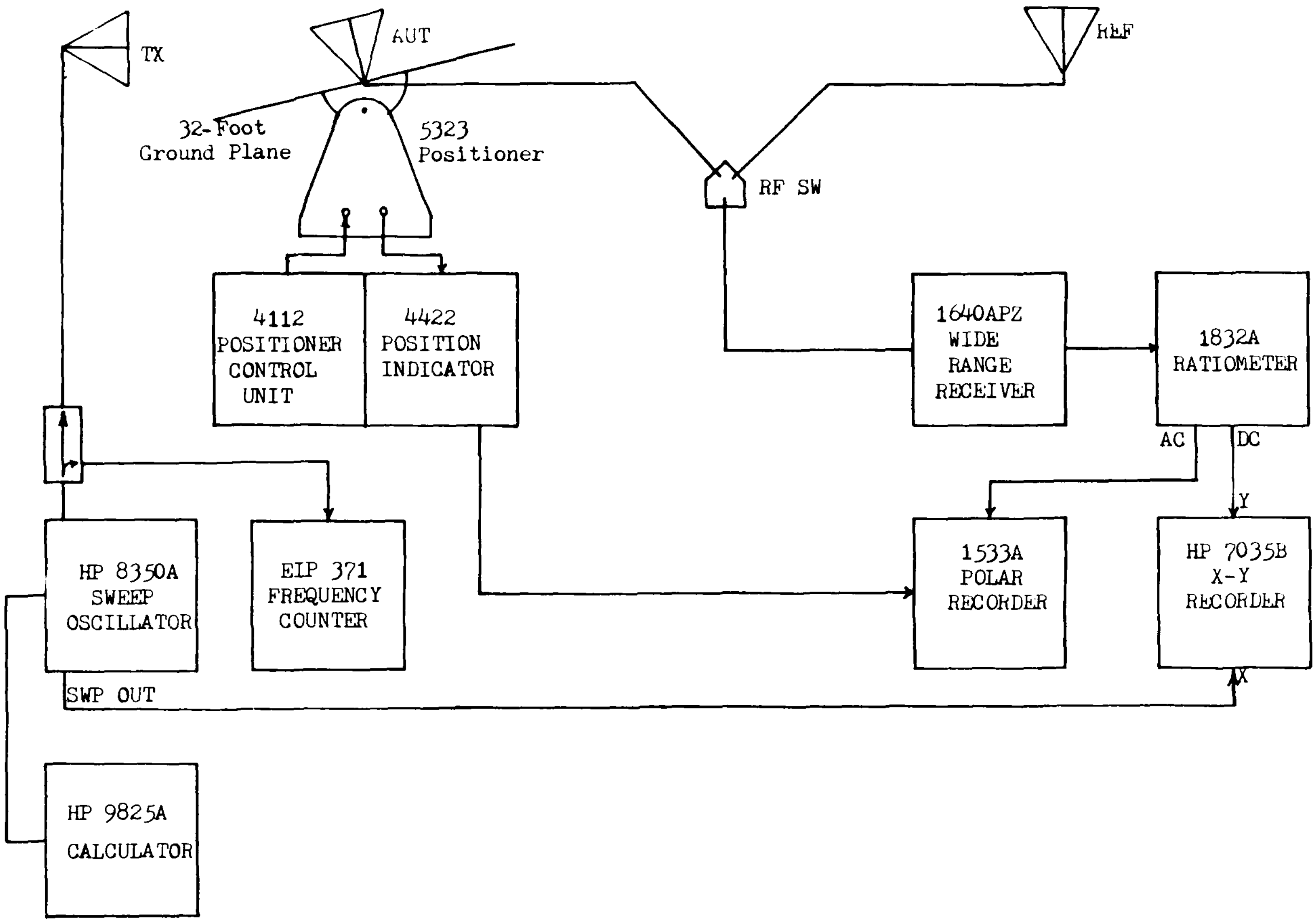

Figure 4. Test Measurement Equipment Configuration.

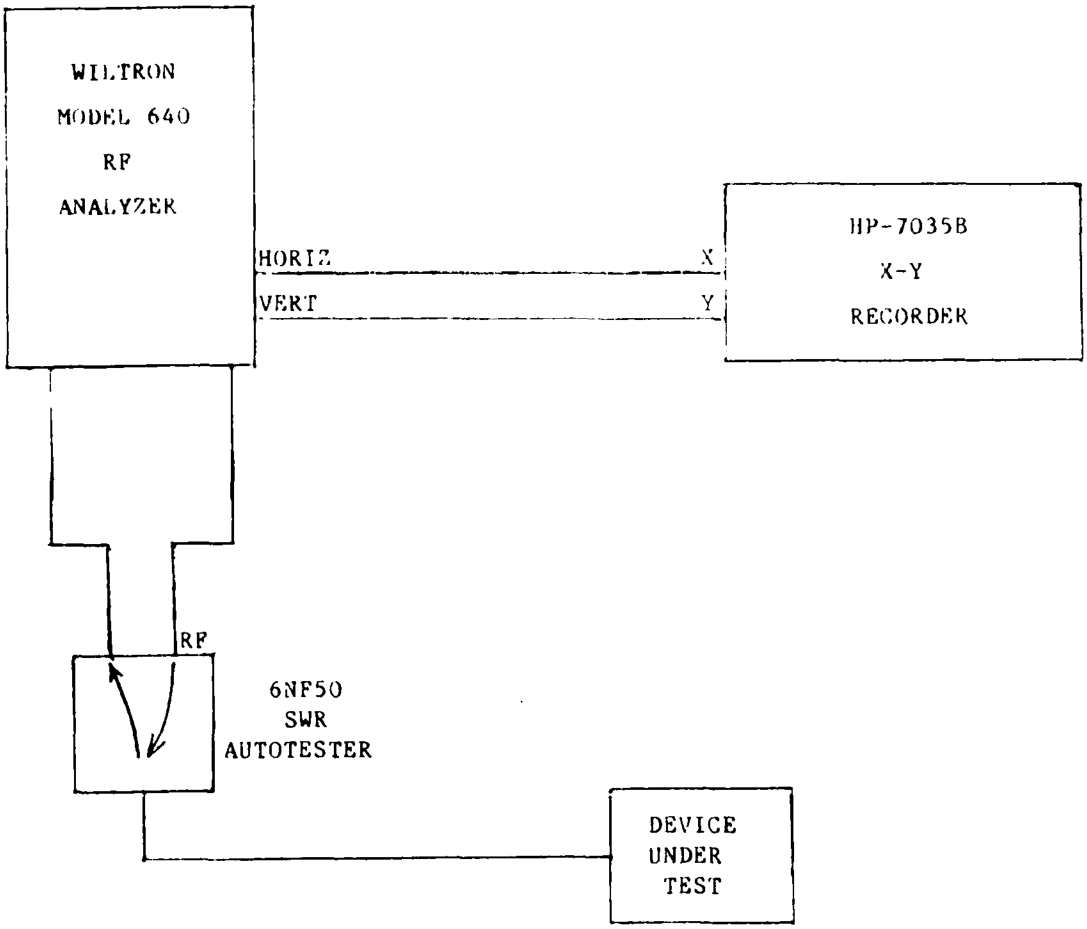

Figure 5. Test Equipment Configuration for VSWR Measurement.

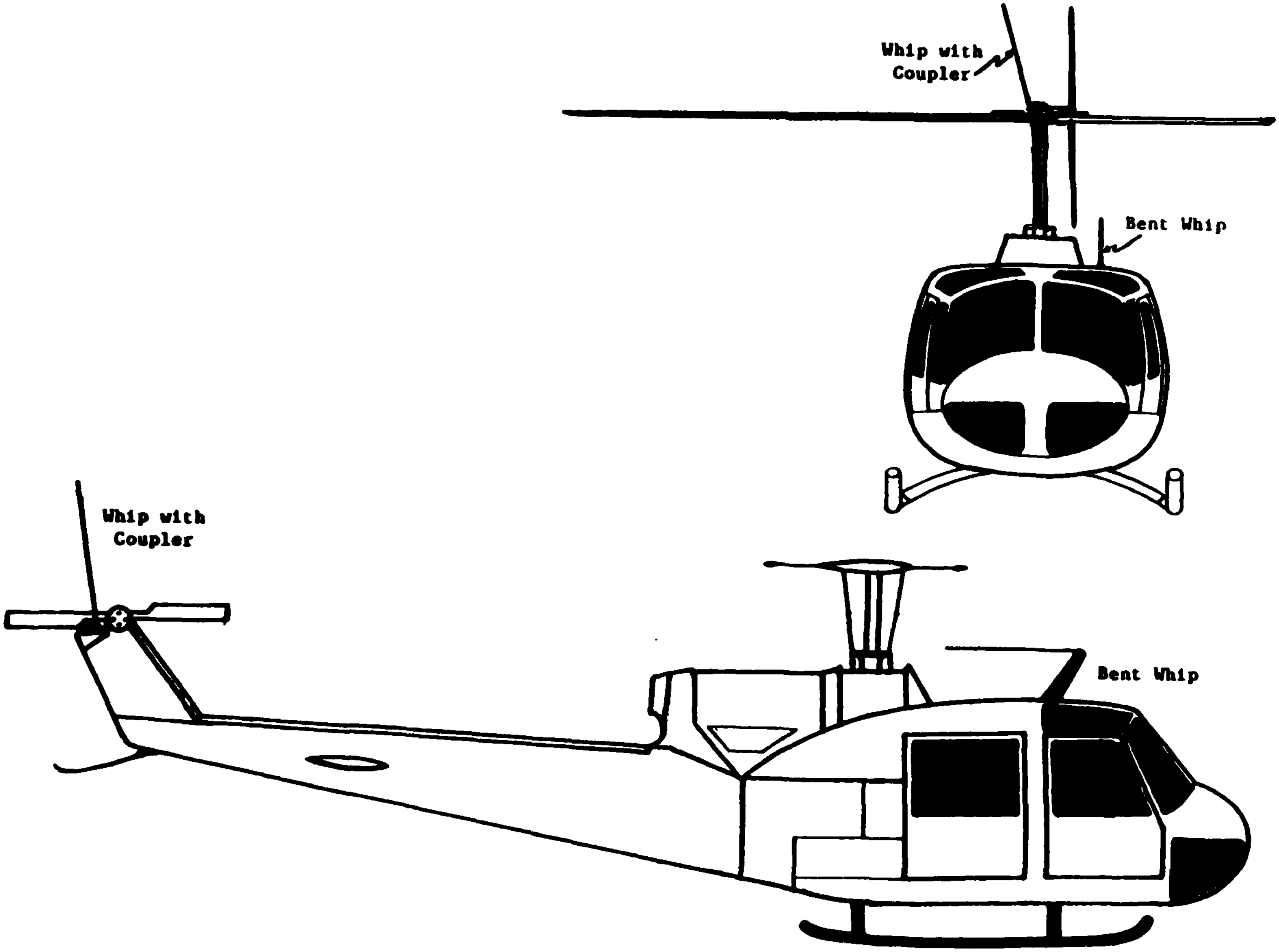

Figure 6. Antenna Locations on UH-1B Helicopter.

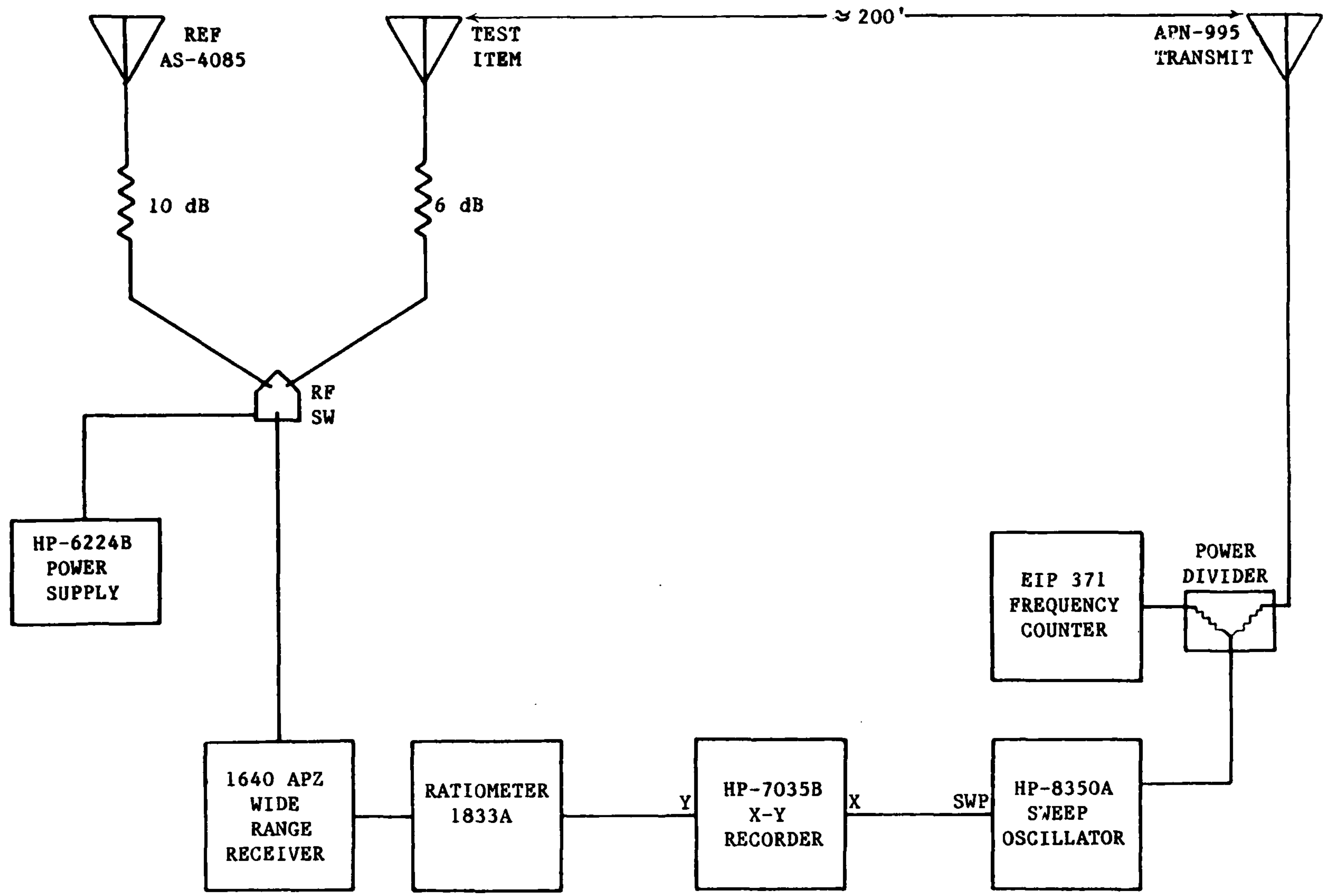

Figure 7. Full Scale Helicopter Test Equipment Configuration.

6. TEST PROCEDURE

a. Swept Frequency Gain Measurements. Throughout the test measurements, the transmit field strength was monitored prior to the start of each sweep (via the reference antenna shown in Figure 4). This was to assure that the level did not vary from one sweep to the next.

The SGA was mounted on the ground plane and its receive level was recorded over the frequency band. This was done by setting the sweep oscillator for a slow single sweep cycle (50 seconds) and then locking the receiver on the start frequency with the Automatic Frequency Control (AFC). The oscillator was then triggered and the antenna response was plotted. The SGA was then removed, the first coupler with its associated whip antenna mounted, and its response recorded.

The above procedure was repeated for all of the test items.

b. VSWR on Ground Plane. VSWR was recorded using the equipment configuration in Figure 5. The "REF" and known VSWR traces were recorded by placing a short at the end of the 4-foot length of RG-214 coaxial cable where the test item is to be connected and adding known attenuations in the "Return Loss" line according to the formula:

$$\text{Return Loss} = -20 \text{ Log } \frac{\text{VSWR-1}}{\text{VSWR-1}}$$

e.g. 3:1 VSWR = 6.02 dB Return Loss

Once the reference lines were recorded, the attenuation in the "Return Loss" line was removed and the short at the end of the coaxial cable was replaced with the first test item. The VSWR of the test item was then recorded. This procedure was repeated for all test items.

c. Swept Frequency Gain Measurements on Helicopter. For each measurement, the test item was mounted on the helicopter and connected to the receiver through a 6-dB pad and an RF switch. The other input port of the switch was connected to the reference antenna through a 10-dB pad to reduce its receive level.

The reference antenna receive level was monitored prior to the start of each sweep to assure that the transmit field strength did not vary from one sweep to the next.

The receiver input was switched to the reference antenna and its response was recorded over the frequency band. This was done by setting the sweep oscillator to a slow single cycle sweep (50 seconds) and then locking the receiver on the start frequency with the Automatic Frequency Control (AFC) prior to the start of the sweep. The receiver input was then switched to the first test item and its response recorded.

This procedure was repeated for all test items with the UH-1 in the two test positions: front and right side.

d. VSWR on Helicopter. VSWR was measured on the helicopter using the same procedure as for the ground plane described in b above.

7. DATA PRESENTATION

a. Ground Plane Swept Frequency Gain Data. The swept frequency data was reduced and plotted in a frequency versus gain (dBi) format. The different possible whip antennas to be used with each test item were plotted on the same graph. Several selected couplers were also plotted against the CU-942B/AS-1703 for comparison.

The gain plots are presented as follows:

Figure 8. CU-942B/AS-1703 and CU-942B/FM 11-22-7.

Figure 9. FM 20-22-7/FM 11-22-6 and FM 20-22-7/FM 11-227.

Figure 10. AV 11-401B/AV 10-401B.

Figure 11. AV-1011/Standard and AV-1011/FM 11-22-7.

Figure 12. FM 10-22-6/FM 11-22-6 and FM 10-22-6/FM 11-22-7.

Figure 13. AO-1955/AS-1703 and AO-1955/FM 11-22-7.

Figure 14. CU-942B/AS-1703, AV 11-401B/AV 10-401B and AV-1011/FM 11-22-7.

Figure 15. CU-942B/AS-1703, FM 20-22-7/FM 11-22-6 and FM 20-22-7/FM 11-22-7.

The best combination of coupler and whip antenna for each candidate test item was then plotted against each other and the result is shown in Figure 16.

The swept frequency patterns on the ground plane were cataloged and are presented in Appendix A as recorded.

b. Helicopter Swept Frequency Gain Data. The helicopter swept frequency data was reduced and plotted against the output of the reference antenna. This was accomplished by first normalizing the reference antenna signal level and plotting the test item deviation from that level. Although the data measured on the 32-foot ground plane shows a flat response over the 30-88 MHz frequency band for some of the antennas, the data measured on the helicopter shows more extreme data variations. This may or may not actually occur since absolute gain was not measured. However, it is not inconceivable that these gain perturbations could have occurred when the antennas were mounted on the helicopter. Although the plotted levels are not absolute values, they are relative to each other and show the gain differences between the test items. The gain plots have been cataloged and are presented in the Appendices as follows:

Appendix B. Right Side of Helicopter

Appendix C. Front of Helicopter

The relative gain between the best combination of coupler and whip antenna for each candidate test item was then plotted against each other and the CU-942B/AS-1703. This was accomplished by first normalizing the CU-942B signal level and plotting the test item deviation from that level. The results are presented as follows:

Figure 17. Right Side of Helicopter.

Figure 18. Front of Helicopter.

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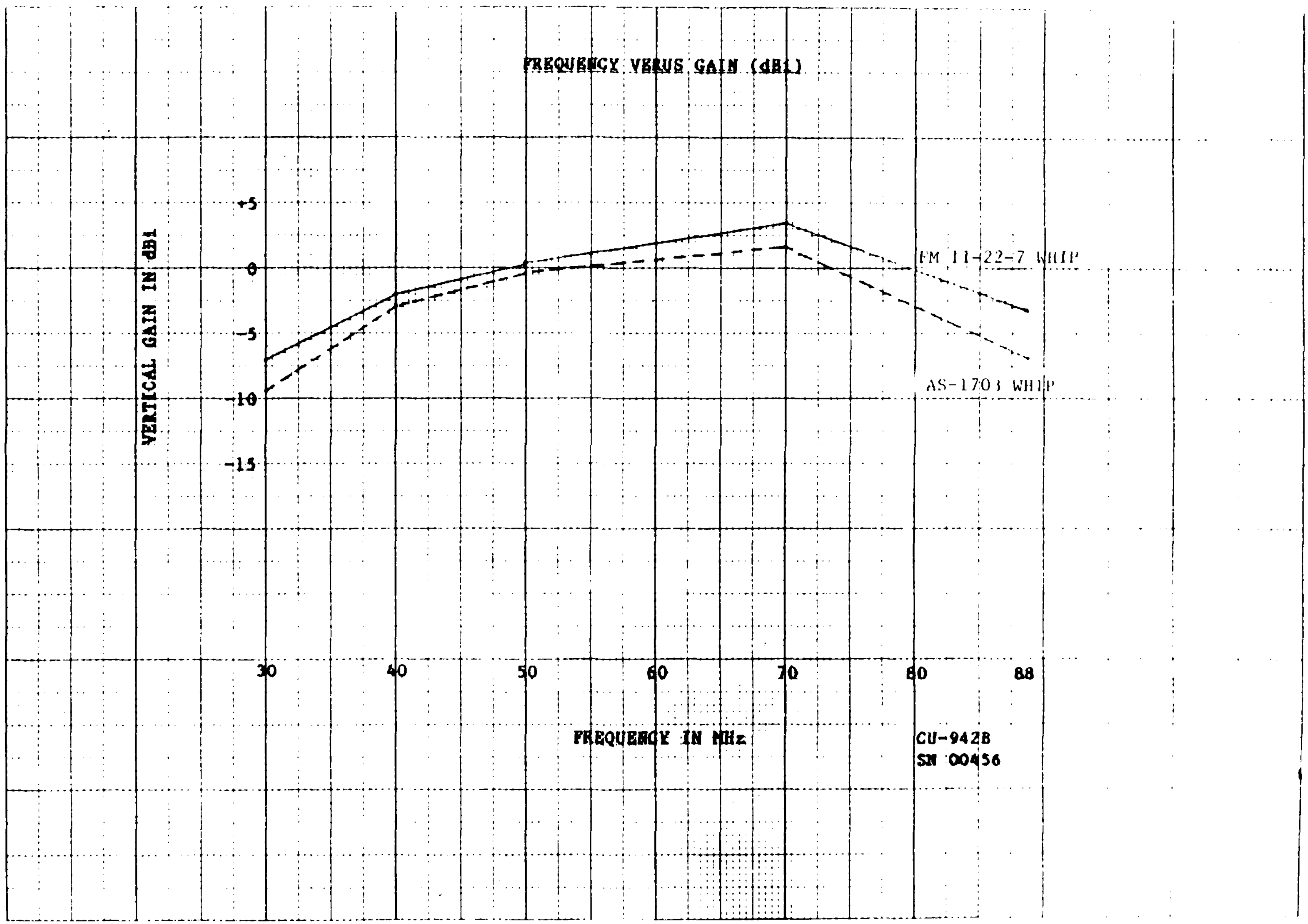

Figure 8. Gain Plot CU-942B Coupler.

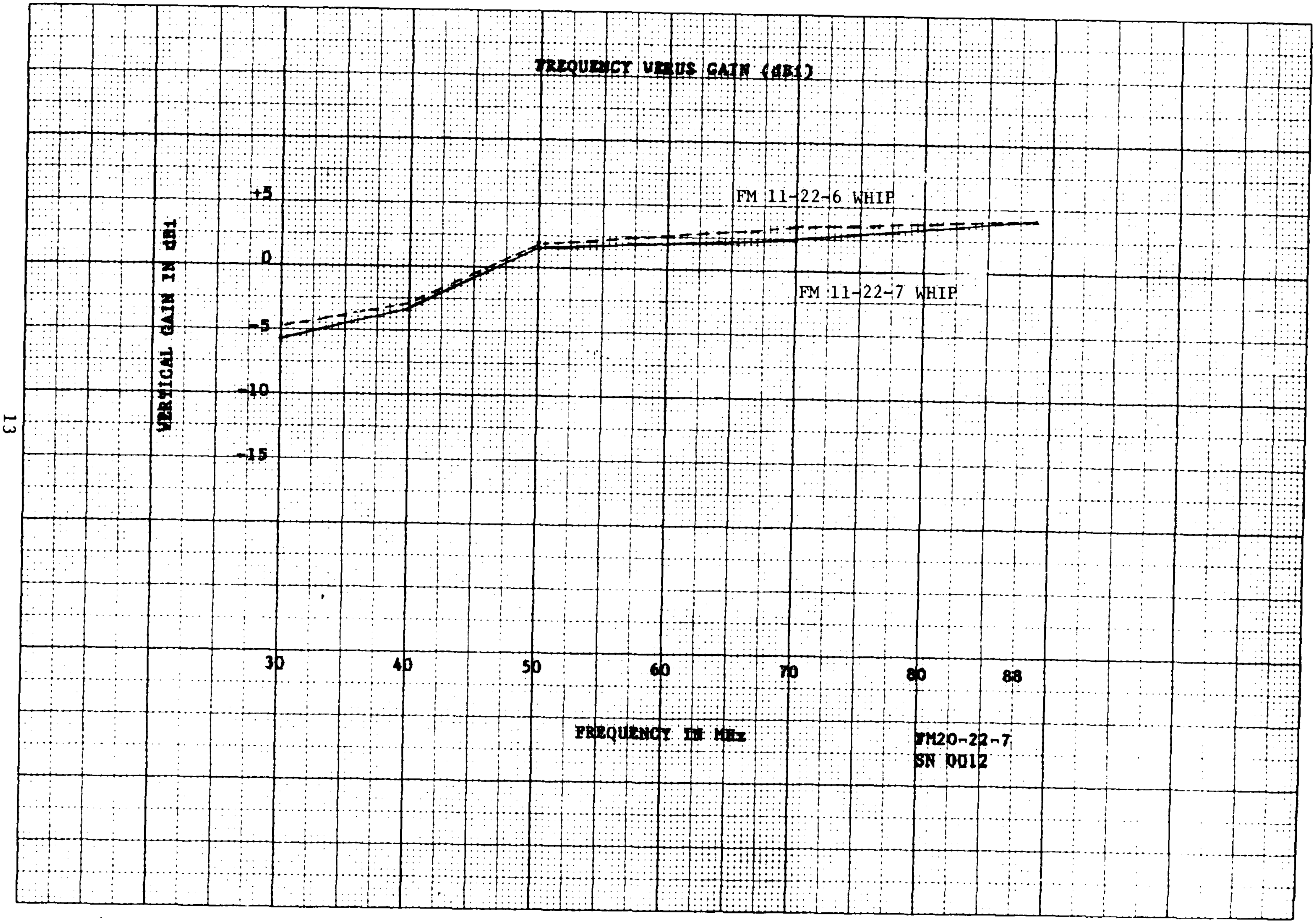

Figure 9. Gain Plot FM 20-22-7 Coupler.

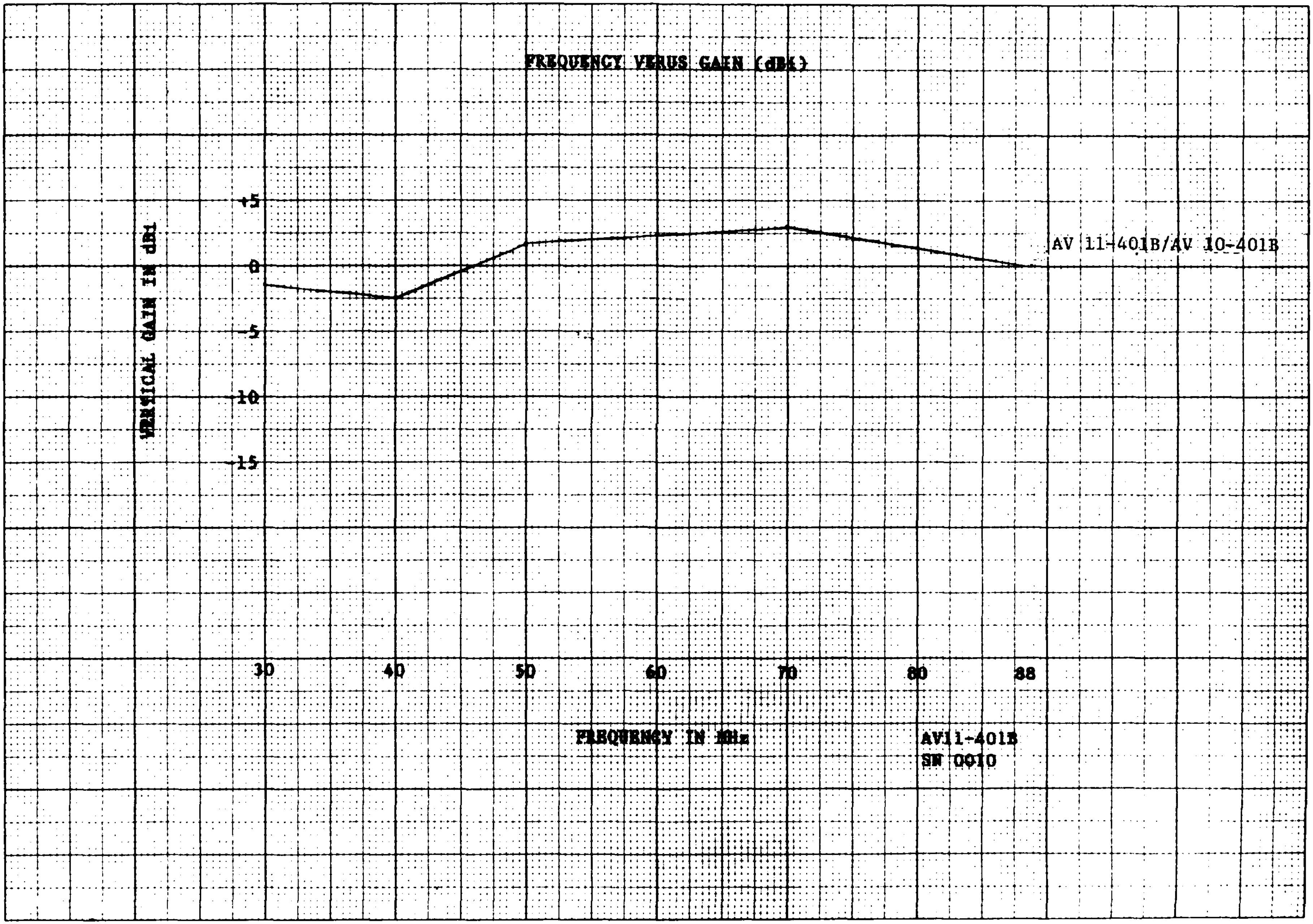

Figure 10. Gain Plot AV 11-401B Coupler.

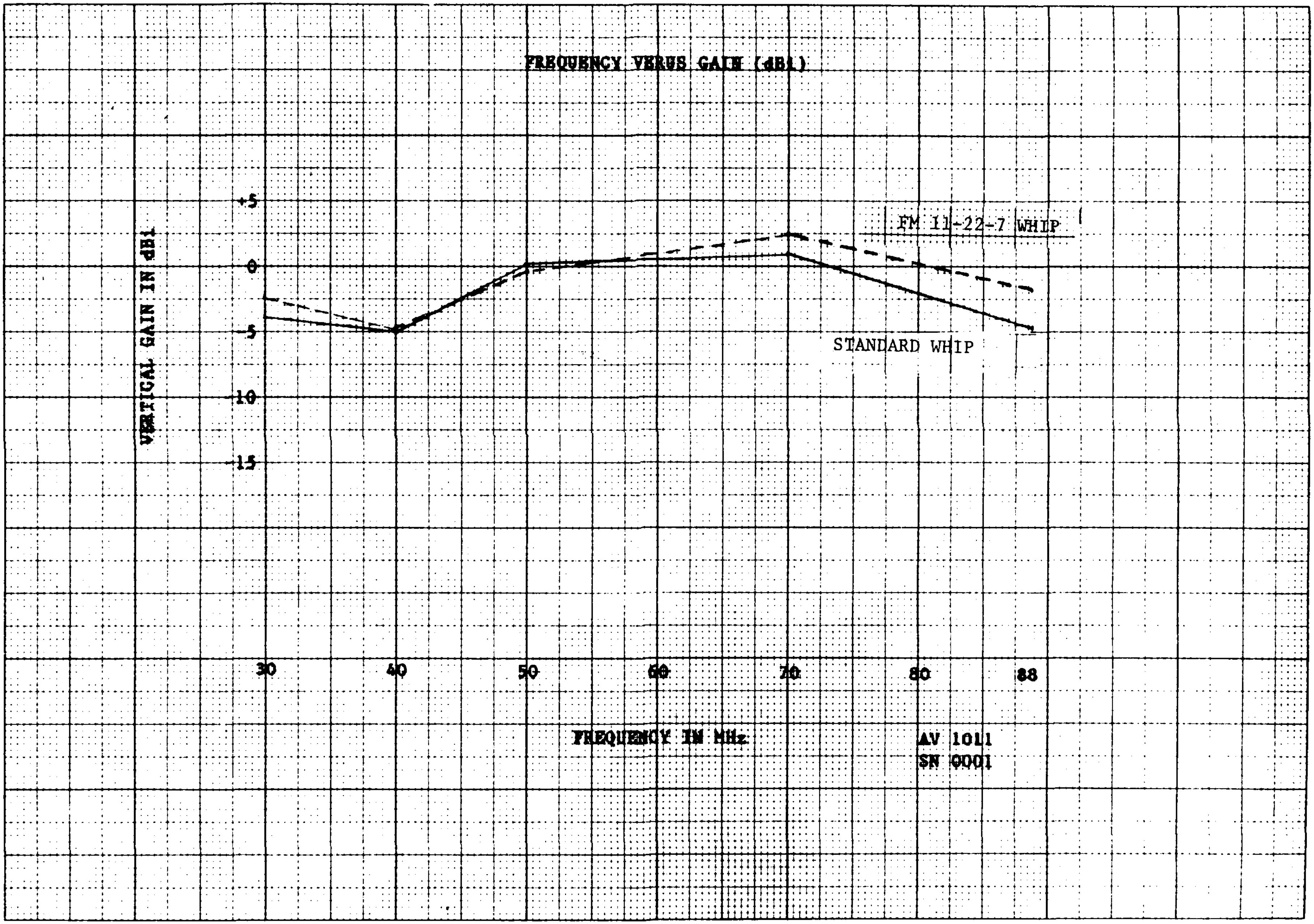

Figure 11. Gain Plot AV-1011 Coupler.

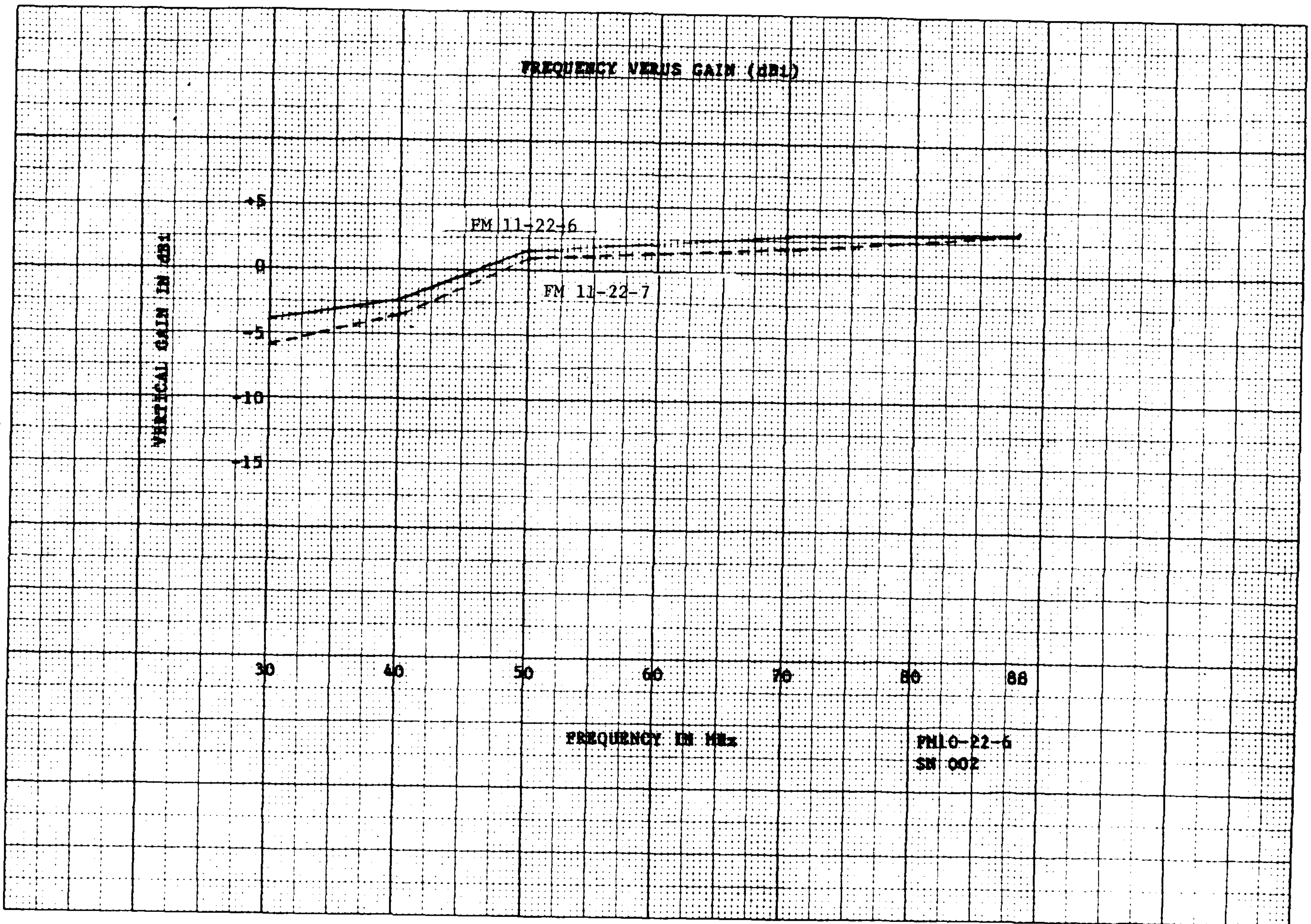

Figure 12. Gain Plot FM 10-22-6 Coupler.

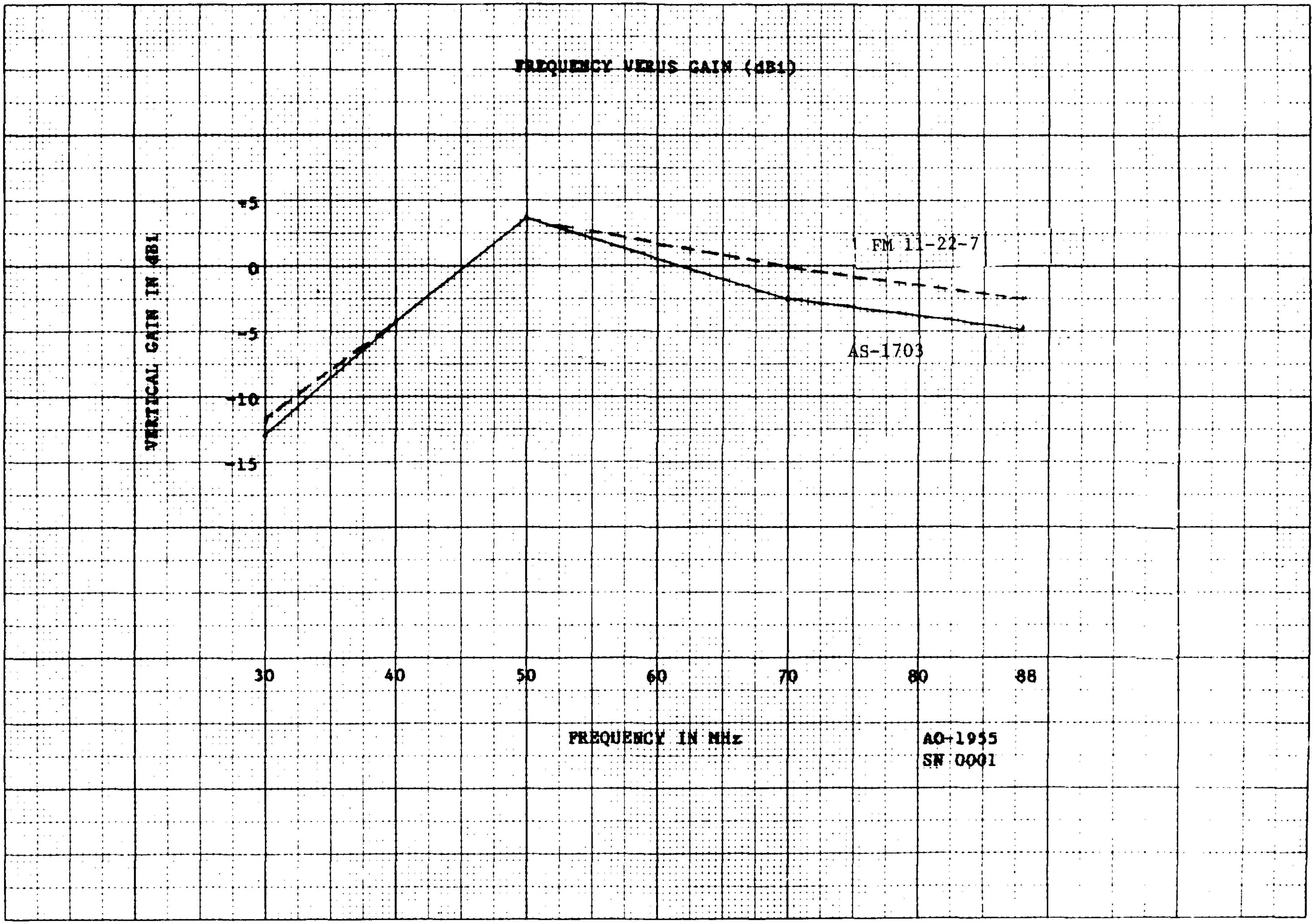

Figure 13. Gain Plot AO-1955 Coupler.

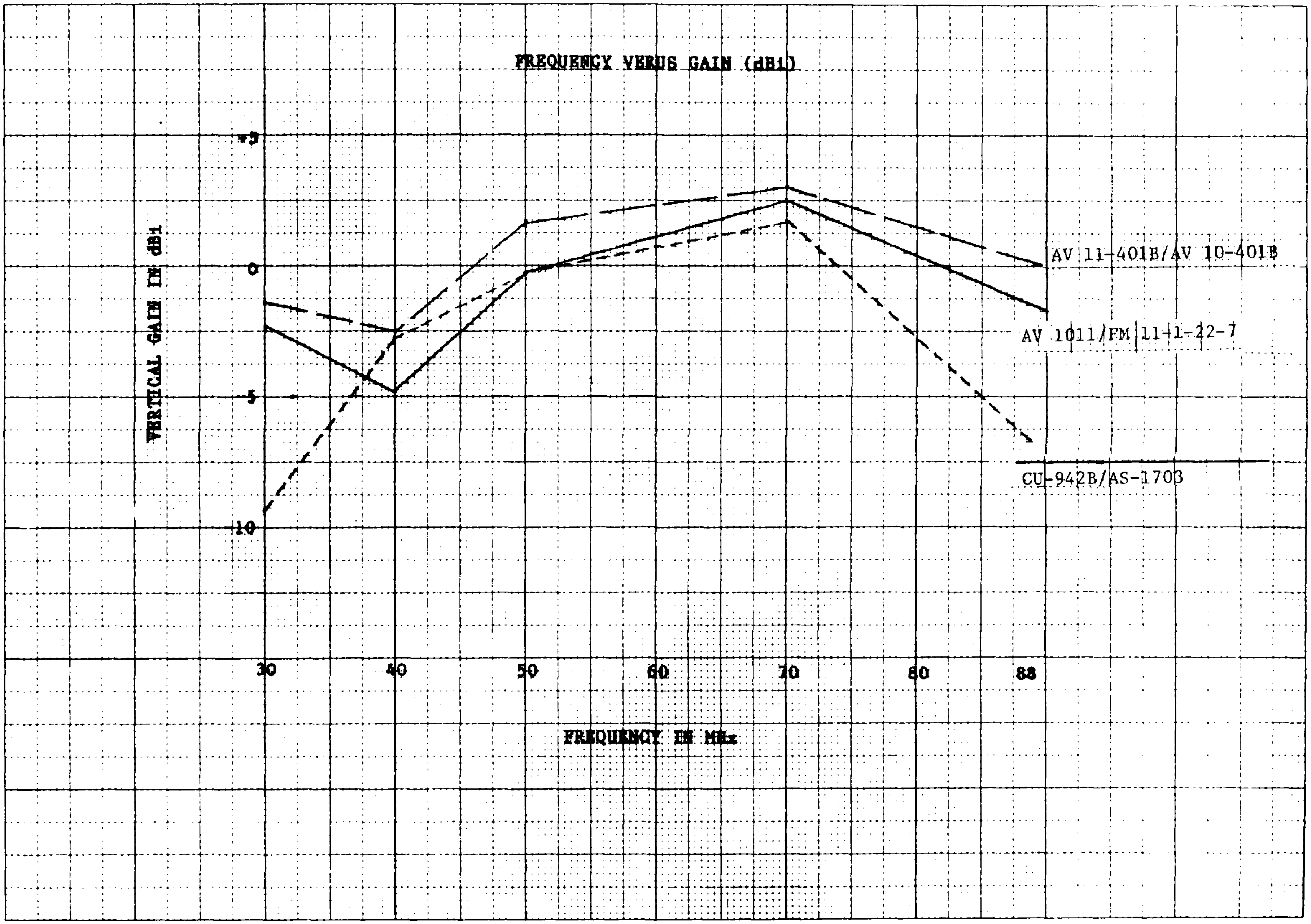

Figure 14. Gain Plot CU-942B and Avant Coupler.

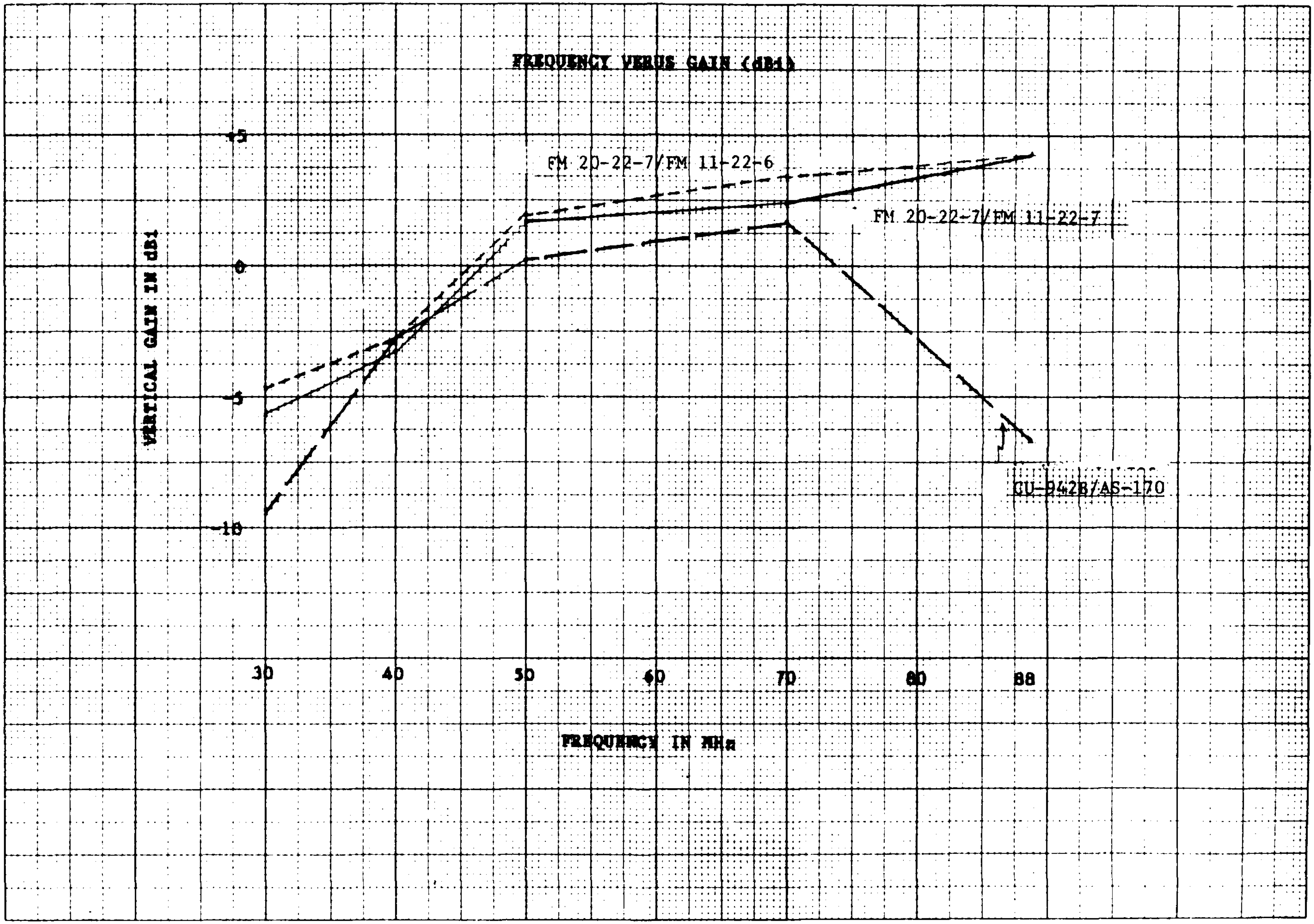

Figure 15. Gain Plot CU-942B and Dayton-Granger Coupler.

Figure 16. Relative Gain Plot of Candidate Test Items.

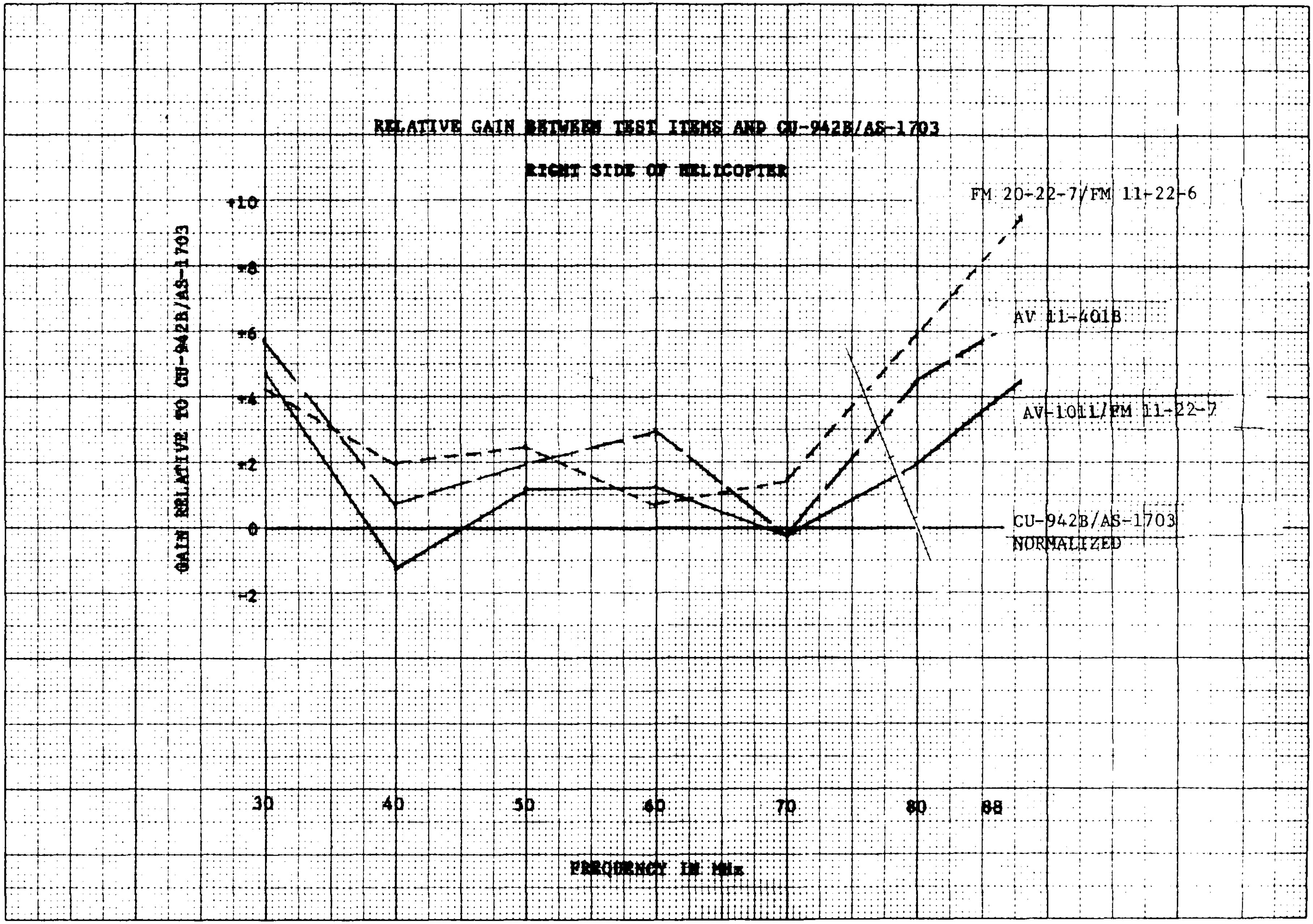

Figure 17. Relative Gain Plot - Right Side of Helicopter.

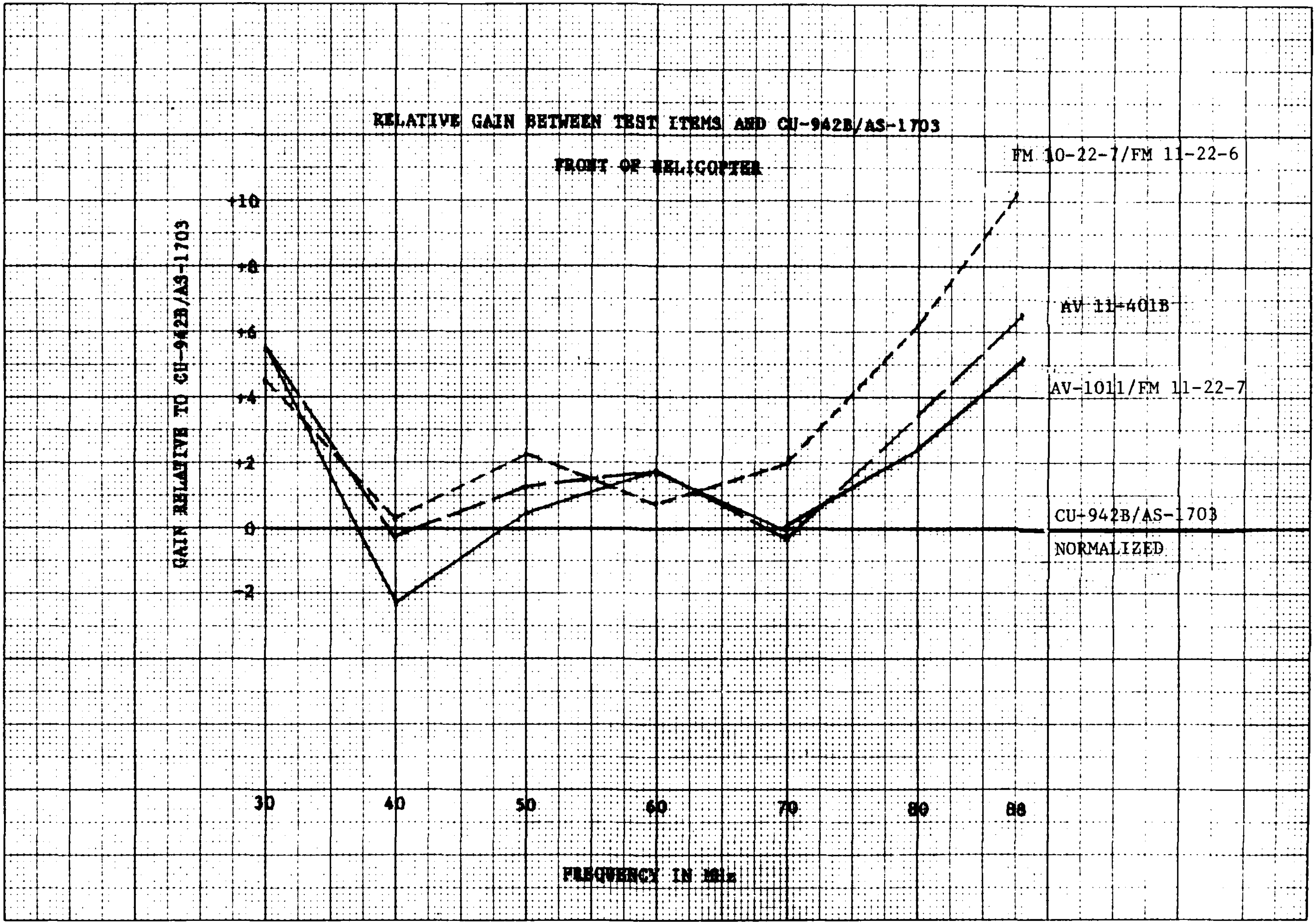

Figure 18. Relative Gain Plot - Front of Helicopter.

The swept frequency patterns have been cataloged and are presented in the Appendices as follows:

Appendix D. Right Side of Helicopter

Appendix E. Front of Helicopter

c. Ground Plane VSWR Data. The VSWR data measured on the 32-foot ground plane was cataloged and is presented in Appendix F as recorded.

c. Helicopter VSWR Data. VSWR data was measured on the UH-1 Helicopter in two different ways: directly at the coaxial connector of the whip and coupler assembly and through the helicopter RG-223/U coaxial transmission cable which was disconnected at the radio RF connector.

The data as measured through the transmission cable show the VSWR presented to the communication equipment in actual operation. The UH-1 in-service CU-942B VSWR was also measured at this time.

The VSWR plots are presented as follows:

Appendix G. VSWR at Couplers

Appendix H. VSWR through Transmission Cable

8. SUMMARY

As stated earlier, the purpose of this test was to determine which of the antenna coupler and whip combinations complied with the following specifications:

Frequency Band:	30-88 MHz
Input Power:	50 Watts (5:1 Duty Cycle)
Antenna Gain:	Gain at 30 MHz no more than 9 dB below gain at 40 MHz
VSWR:	Less than 3.0:1
Average Gain:	Approximately -3 dBi across the band
Gain Variation:	Less than 10 dB across the band

The average VSWR was calculated using the same seven (7) frequencies for all test items. The average gain was calculated using the five (5) frequencies for which the dBi gain had been measured.

A comparison of the different test item configurations versus the above specifications is as follows:

FM 20-22-7/FM 11-22-6	Max. VSWR	Gnd Plane:	2.9:1
		Aircraft:	2.6:1
	Avg. VSWR	Gnd Plane:	2.1:1
		Aircraft:	1.89:1
	Gain Variation	Gnd Plane:	8.9 dB
	Avg. Gain	Gnd Plane:	1.7 dBi
FM 20-22-7/FM 11-22-7	Max. VSWR	Gnd Plane:	2.9:1
		Aircraft:	2.6:1
	Avg. VSWR	Gnd Plane:	2.1:1
		Aircraft:	1.88:1
	Gain Variation	Gnd Plane:	9.9 dB
	Avg. Gain	Gnd Plane:	0.1 dBi
AV-1011/FM 11-22-7	Max. VSWR	Gnd Plane:	2.7:1
		Aircraft:	3.15:1 at 34.5 MHz
	Avg. VSWR	Gnd Plane:	2.0:1
		Aircraft:	2.0:1
	Gain Variation	Gnd Plane:	7.2 dB
	Avg. Gain	Gnd Plane:	0.6 dBi
AV-1011/Standard	Max. VSWR	Gnd Plane:	2.9:1
		Aircraft:	3.25:1 at 35 MHz
	Avg. VSWR	Gnd Plane:	2.4:1
		Aircraft:	2.25:1
	Gain Variation	Gnd Plane:	5.95 dB
	Avg. Gain	Gnd Plane:	0.2 dBi
AV 11-401B/AV 10-501B	Max. VSWR	Gnd Plane:	3.2:1 at 30 MHz
		Aircraft:	3.4:1 at 32.5 MHz
	Avg. VSWR	Gnd Plane:	1.9:1
		Aircraft:	1.83:1
	Gain Variation	Gnd Plane:	5.45 dB
	Avg. Gain	Gnd Plane:	0.7 dBi

The specifications that the gain at 30 MHz be no more than 9 dB below the gain at 40 MHz and the average gain (-3 dBi across the band) are met by all candidate test items.

As noted in paragraph 8, the Dayton-Granger Model FM 20-22-7/FM 11-22-6 fully meets the stated specifications. The VSWR as measured on the ground plane and helicopter is less than 3.0:1. The requirement for a gain variation of less than 10 dB across the band is also met.

The Dayton-Granger Model FM 20-22-7/FM 11-22-7 also meets the stated specifications. The VSWR as measured on the ground plane and the helicopter is less than 3.0:1. The gain variation specification is also met but just barely (9.9 dB).

The Avant Model AV-1011/FM 11-22-7 meets all of the specifications except for the maximum VSWR on the helicopter. This out of specification is over a very narrow portion of the frequency band (34 to 36.5 MHz) with the maximum VSWR of 3.15:1 occurring at 34.5 MHz.

The Avant Model AV-1011/Standard has a flatter frequency response across the frequency band (5.95 dB) but the helicopter VSWR also exceeds the specifications at the low end of the band (33.5 to 38 MHz) with a maximum VSWR of 3.25:1 occurring at 35 MHz.

The Avant Model AV 11-401B/AV 10-401B has the flattest of all of the frequency responses (5.45 dB) and the best average VSWR measured on the helicopter. However, the maximum VSWR on the helicopter exceeds the specification at the very low end of the frequency band (31 to 35 MHz) with a maximum of 3.4:1 occurring at 32.5 MHz.

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APPENDIX A. SWEPT FREQUENCY PATTERNS - 32-FOOT GROUND PLANE

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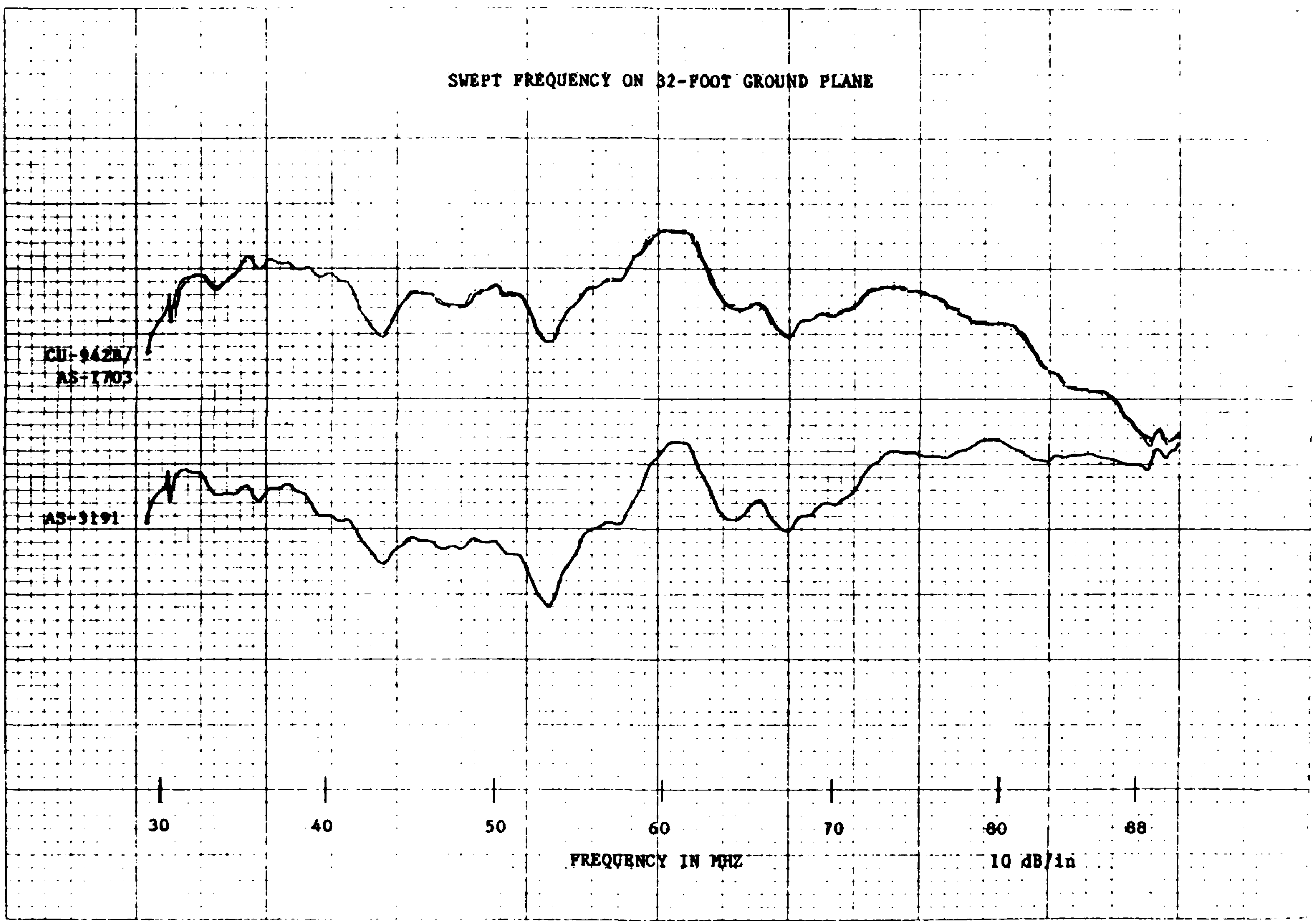
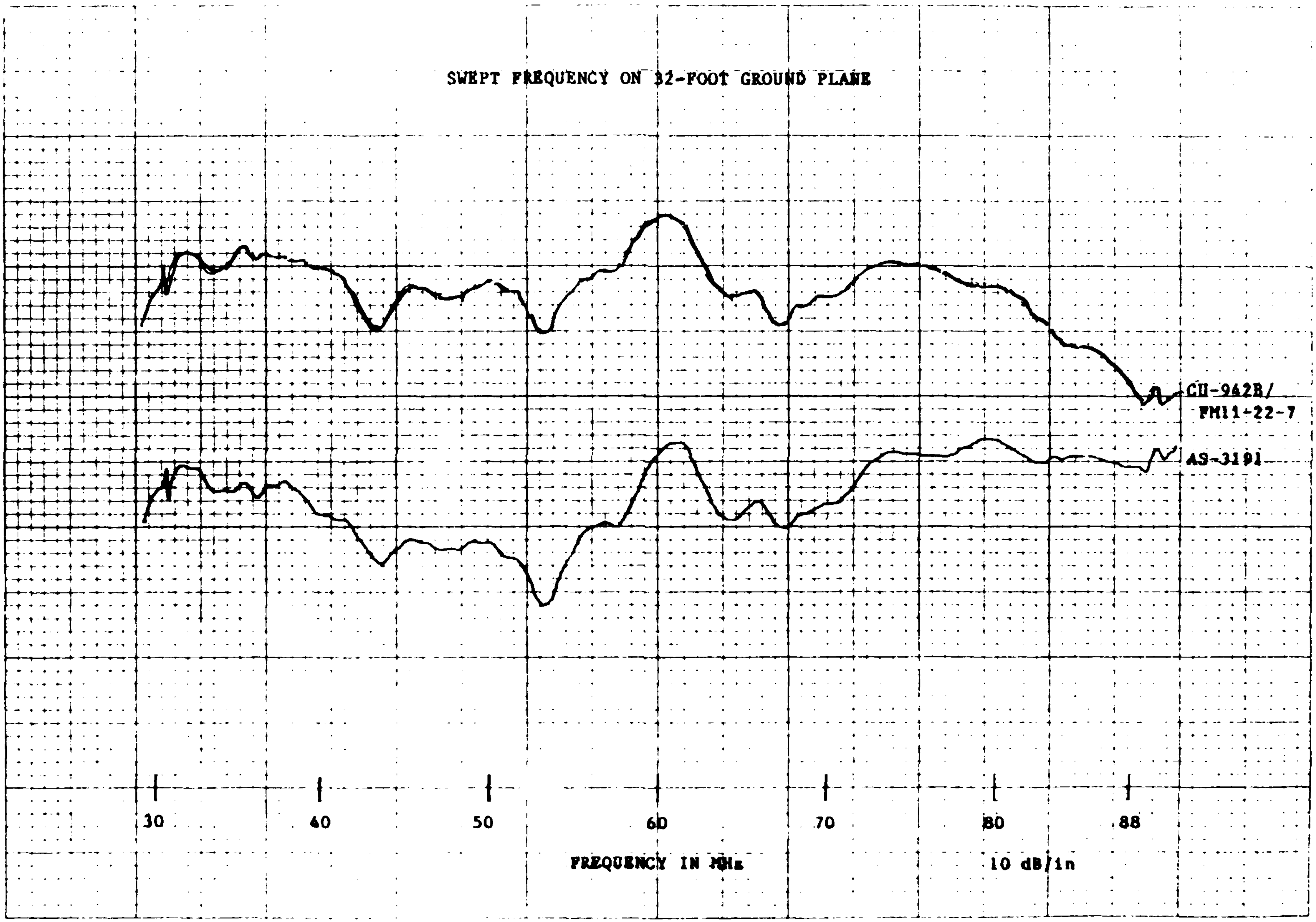
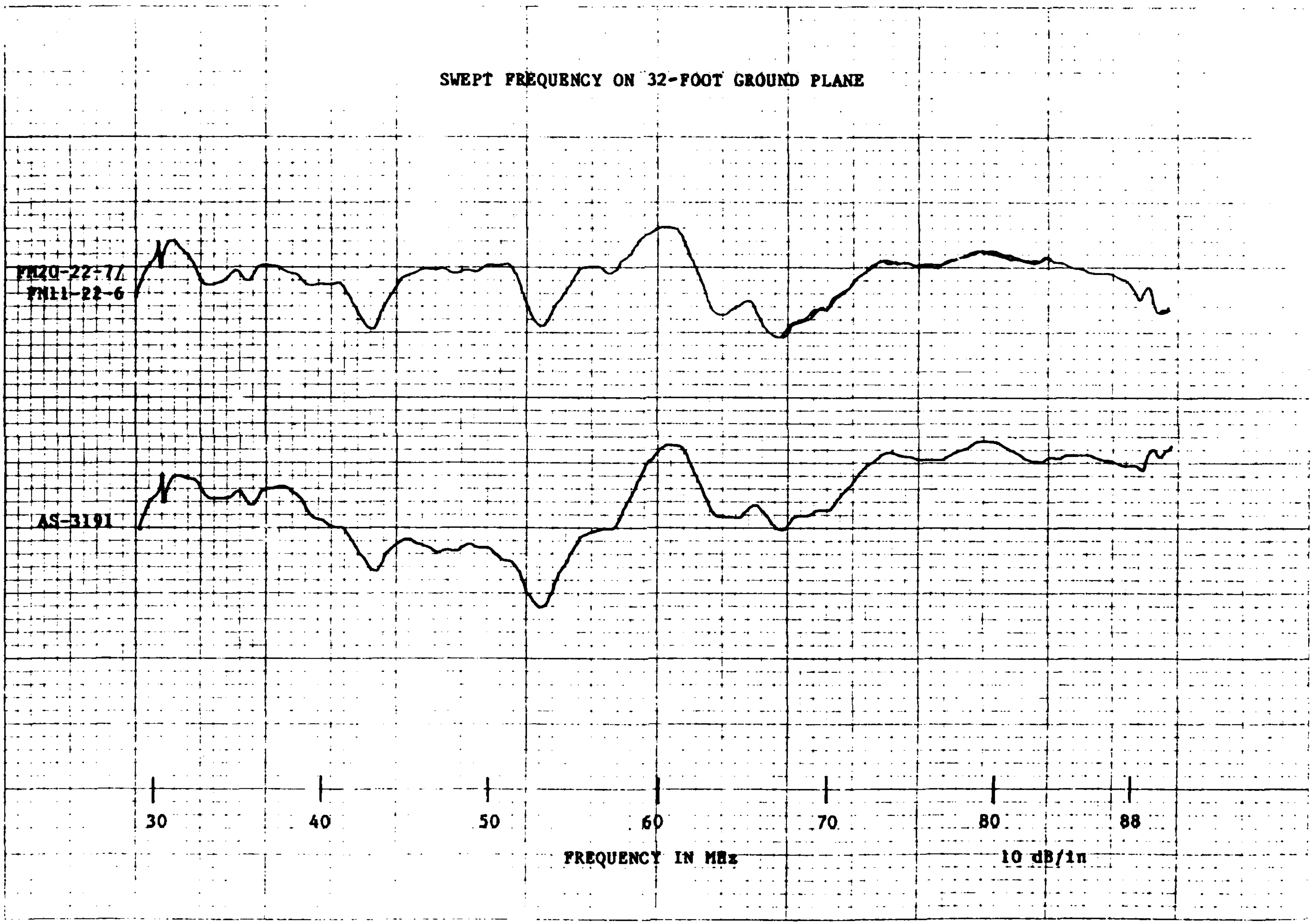
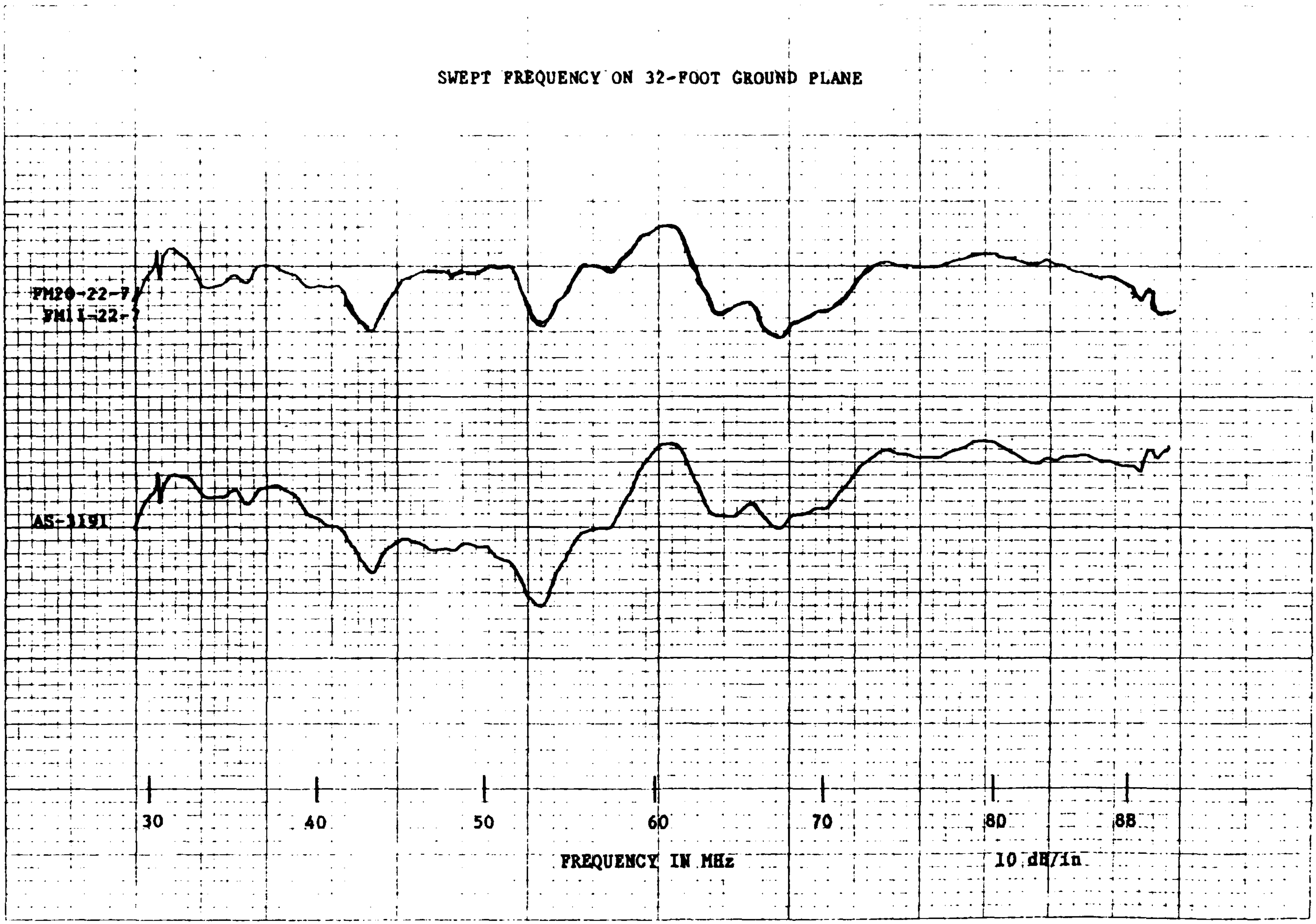
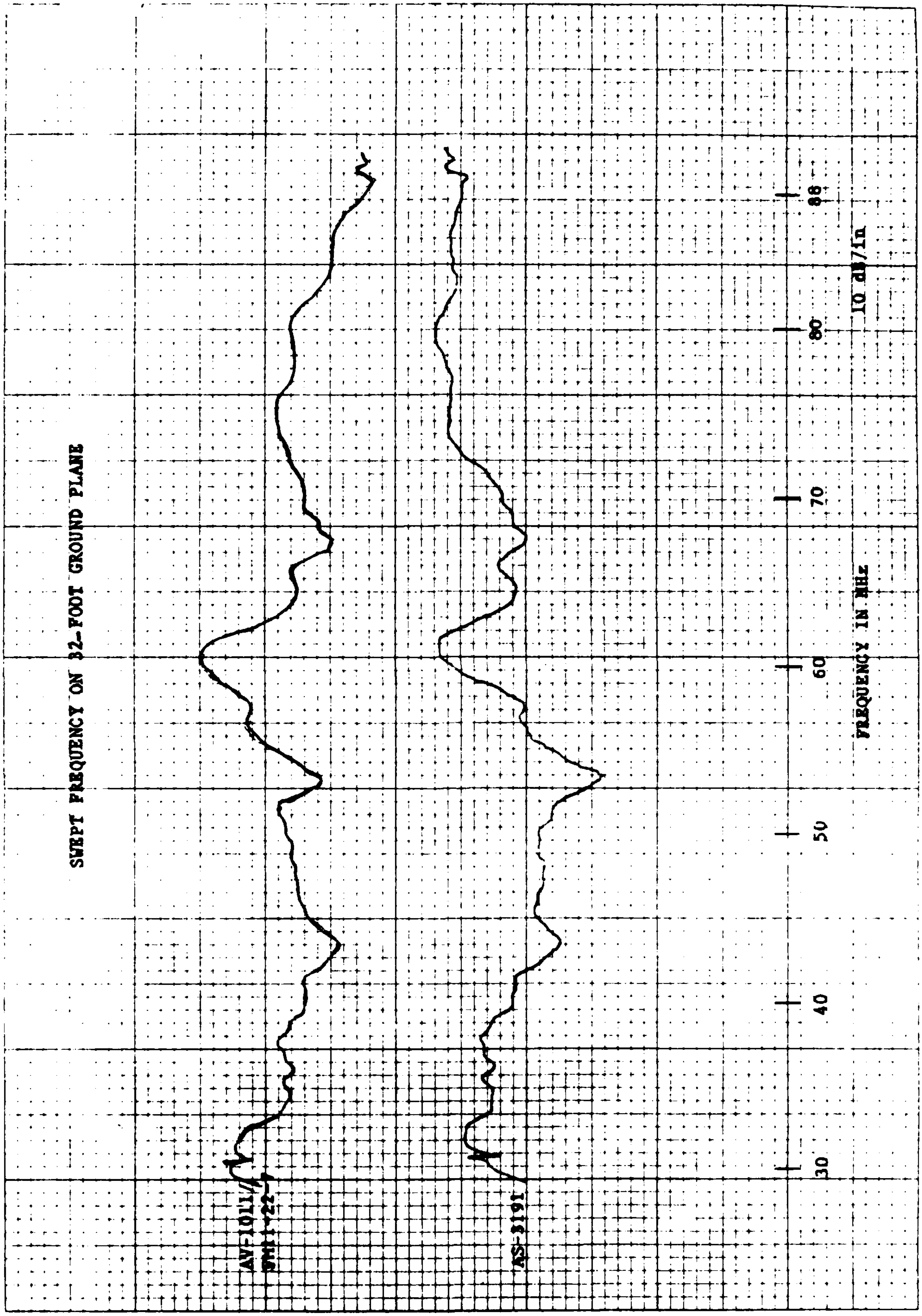
SWEPT FREQUENCY ON 32-FOOT GROUND PLANE



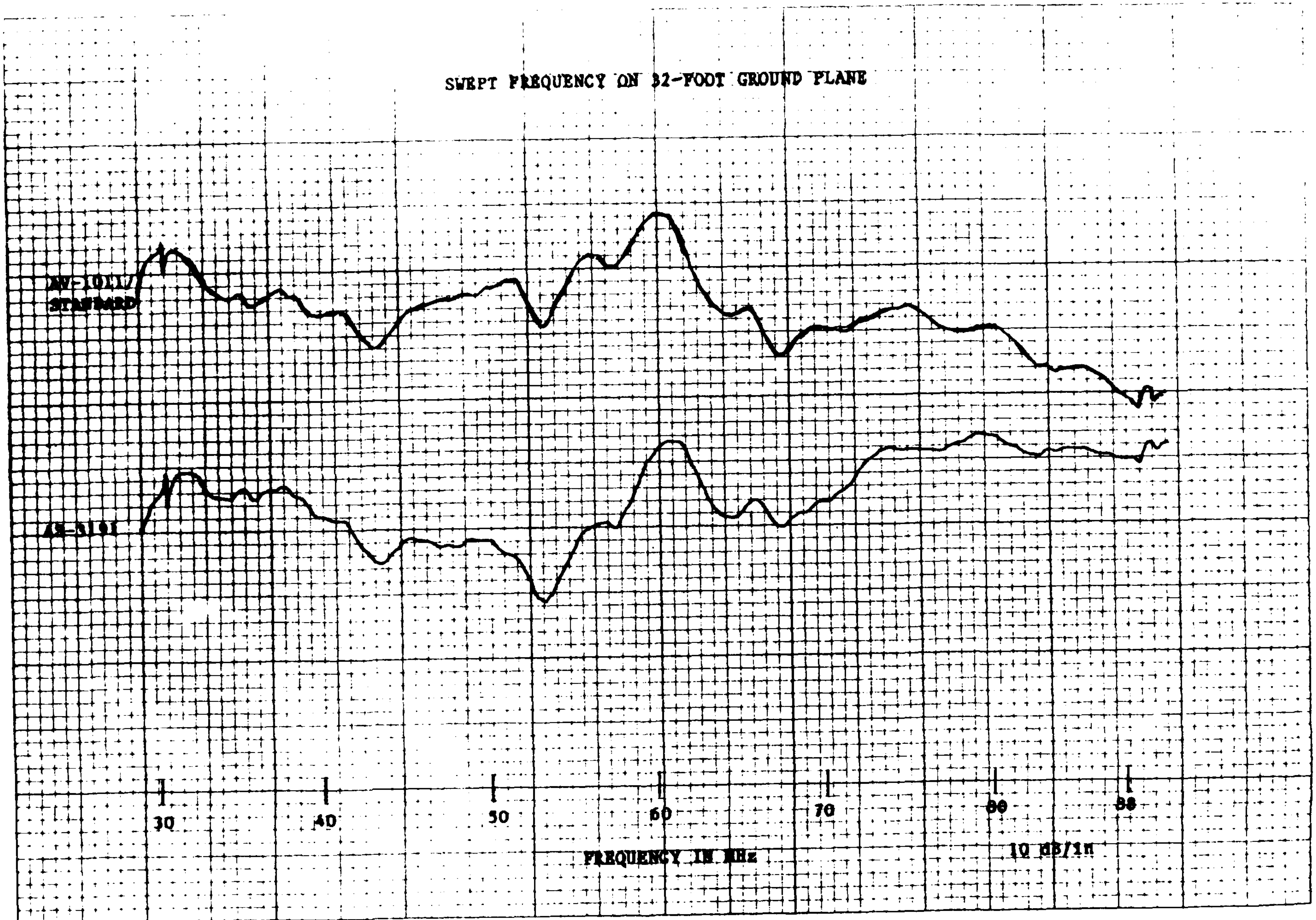

SWEPT FREQUENCY ON 32-FOOT GROUND PLANE
CU-942B/
FM11-22-7
AS-3191
30
40
50
60
70
80
88
FREQUENCY IN MHz
10 dB/in

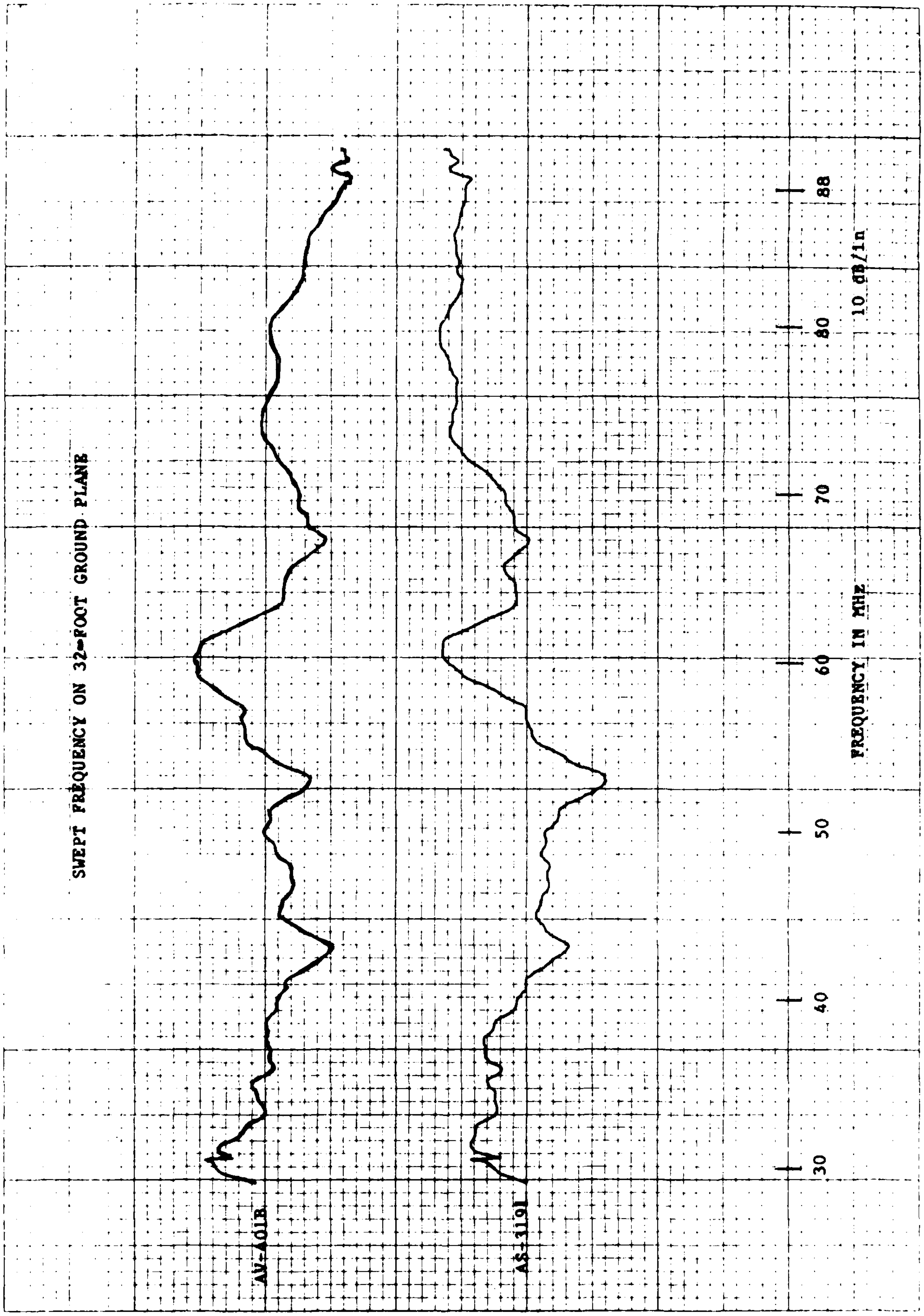

SWEPT FREQUENCY ON 32-FOOT GROUND PLANE
FM20-22-7/
FM11-22-6
AS-3191
30
40
50
60
70
80
88
FREQUENCY IN MHz
10 dB/in

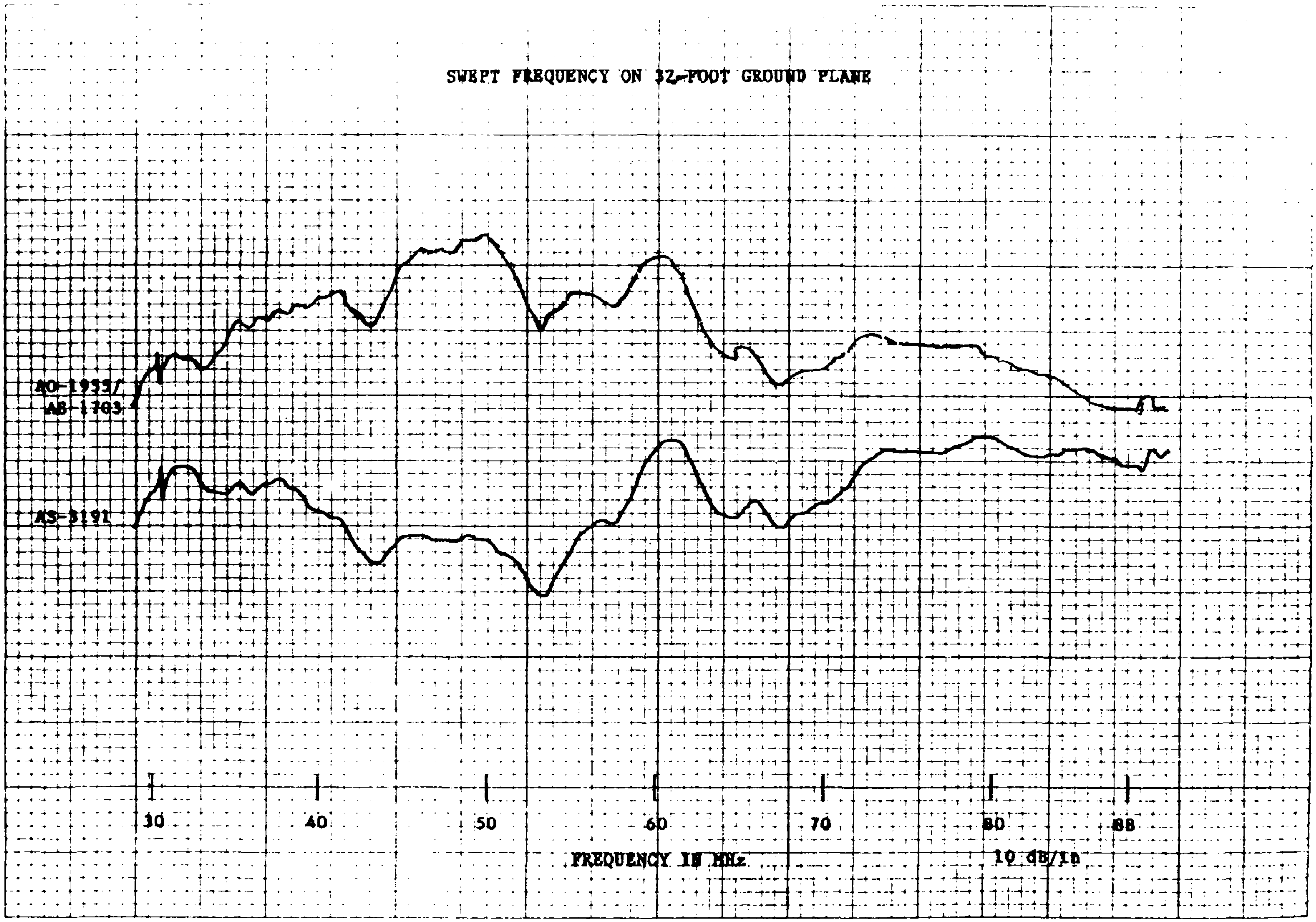

SWEPT FREQUENCY ON 32-FOOT GROUND PLANE
FM20-22-7/
FM11-22-7
AS-3191
30
40
50
60
70
80
88
FREQUENCY IN MHz
10 dB/in

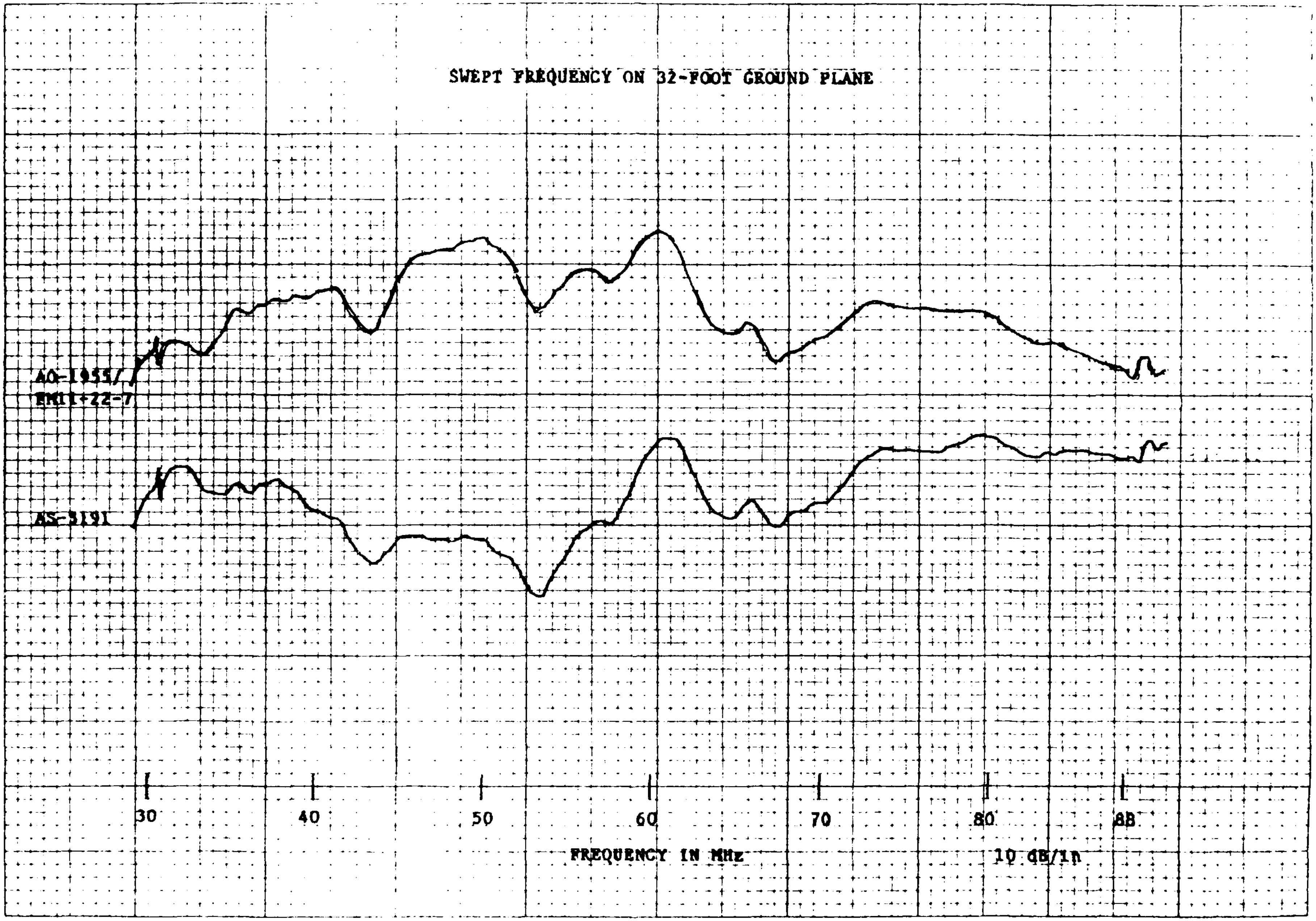

SWEPT FREQUENCY ON 32-FOOT GROUND PLANE
AV-1011/
AS-3191
30
40
50
60
70
80
88
FREQUENCY IN MHz
10 dB/in

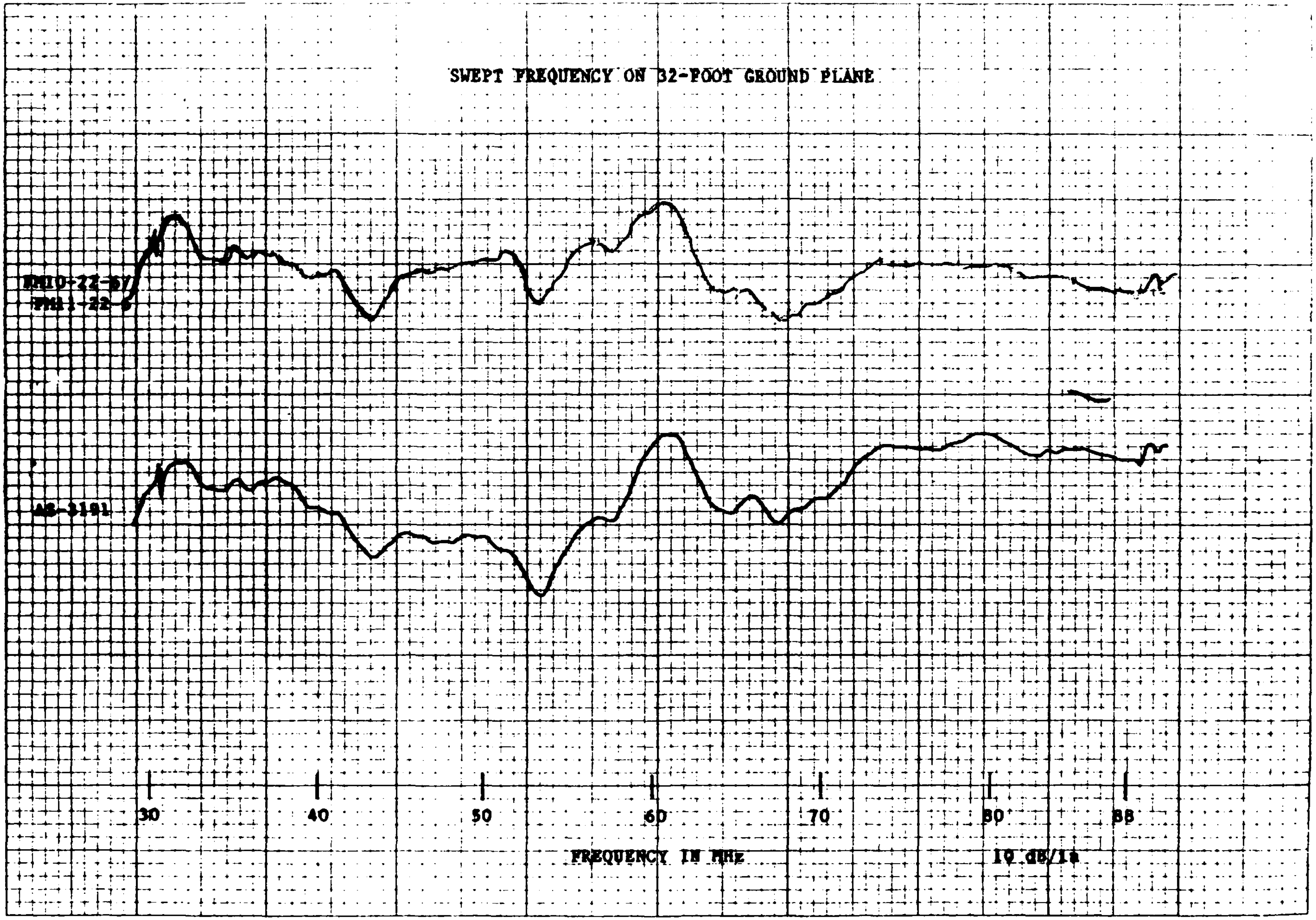
SWEPT FREQUENCY ON 32-FOOT GROUND PLANE

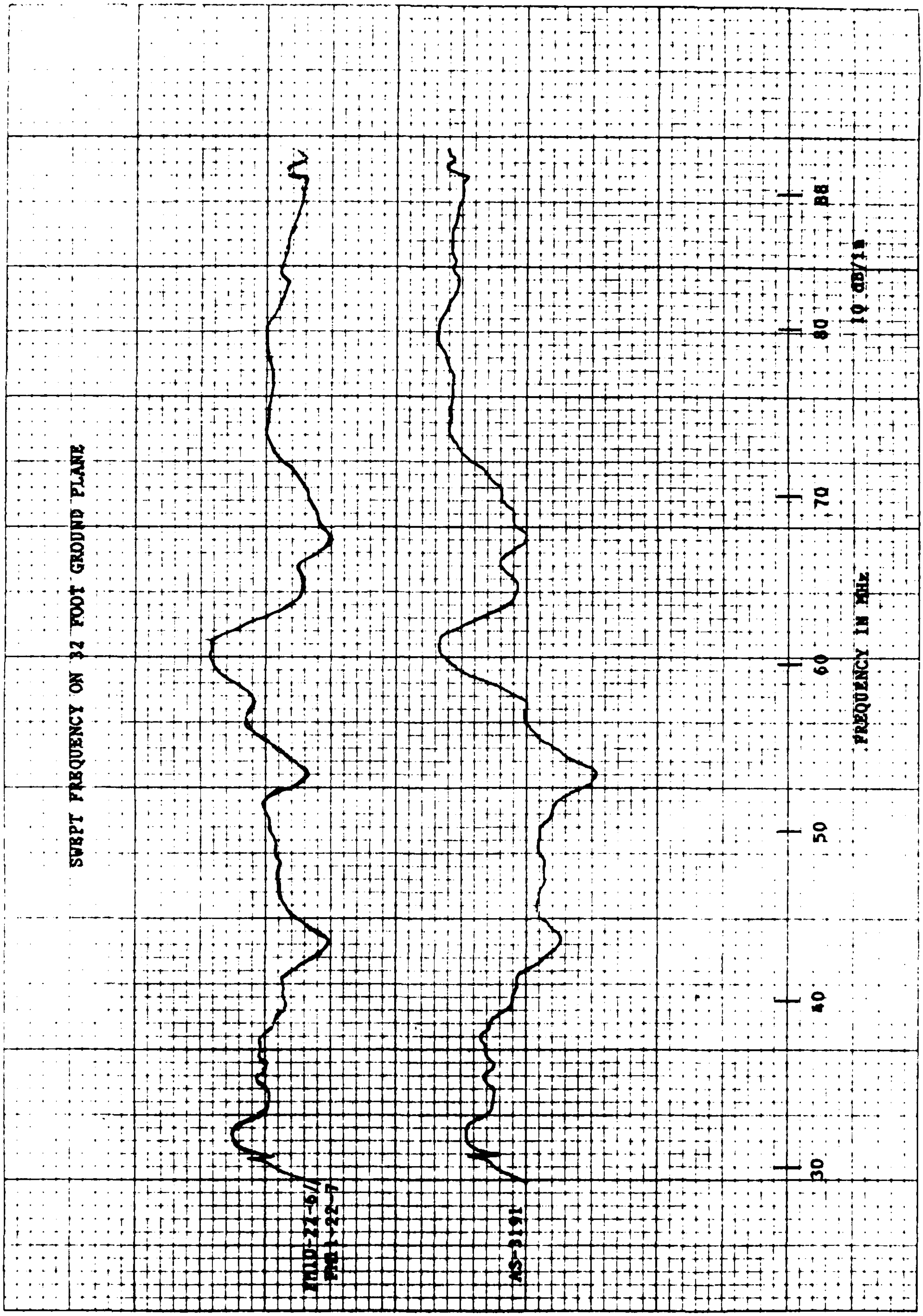



SWEPT FREQUENCY ON 32-FOOT GROUND PLANE
AV-401B
AS-3191
30
40
50
60
70
80
88
FREQUENCY IN MHz
10 dB/in


SWEPT FREQUENCY ON 32-FOOT GROUND PLANE
AO-1955/
AB-1703
AS-3191
30
40
50
60
70
80
88
FREQUENCY IN MHz
10 dB/in


SWEPT FREQUENCY ON 32-FOOT GROUND PLANE
AO-1955/
AS-3191
30
40
50
60
70
80
88
FREQUENCY IN MHz
10 dB/in


SWEPT FREQUENCY ON 32-FOOT GROUND PLANE
30
40
50
60
70
80
88
FREQUENCY IN MHz
10 dB/in



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APPENDIX B. GAIN PLOTS - RIGHT SIDE OF HELICOPTER

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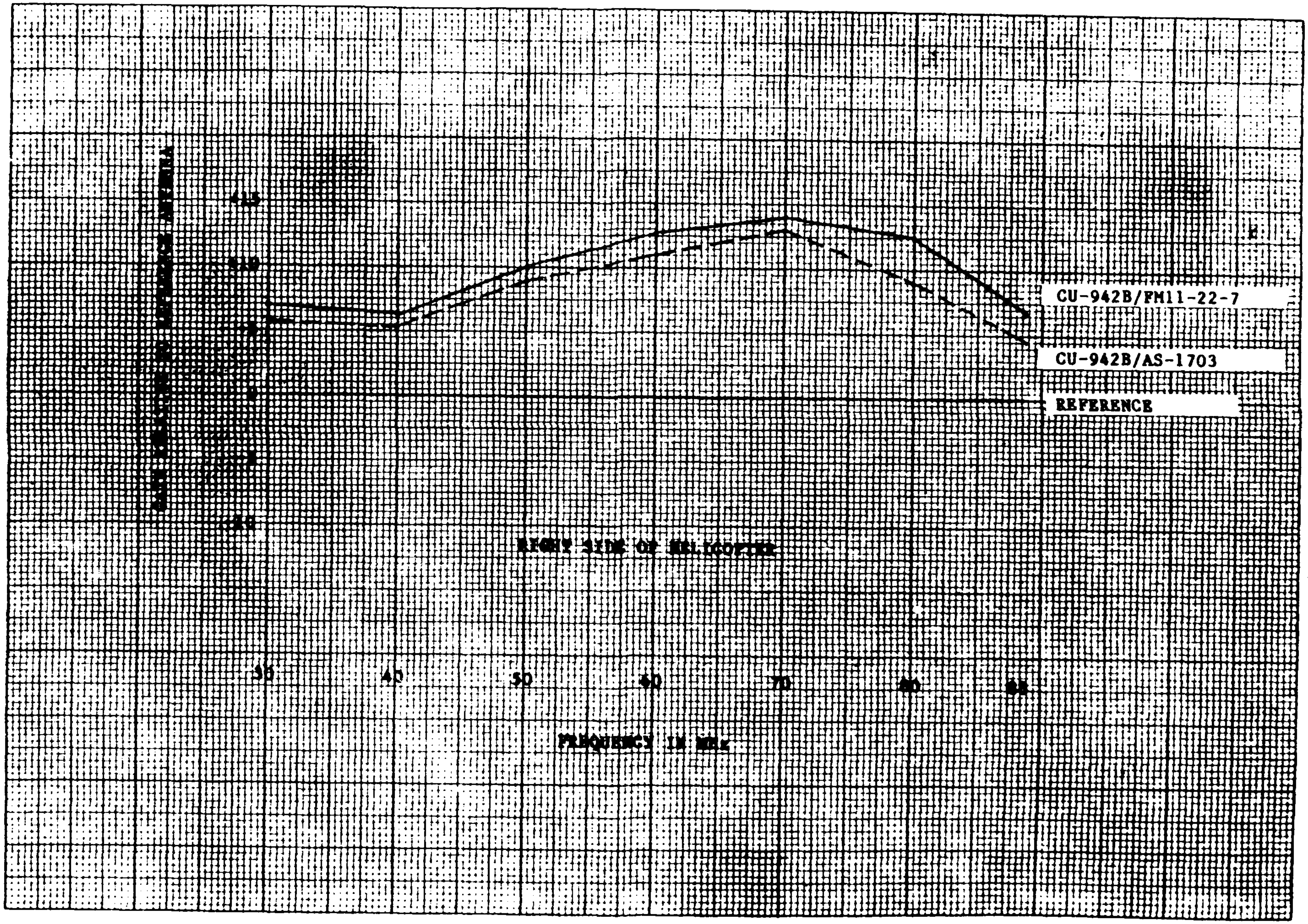
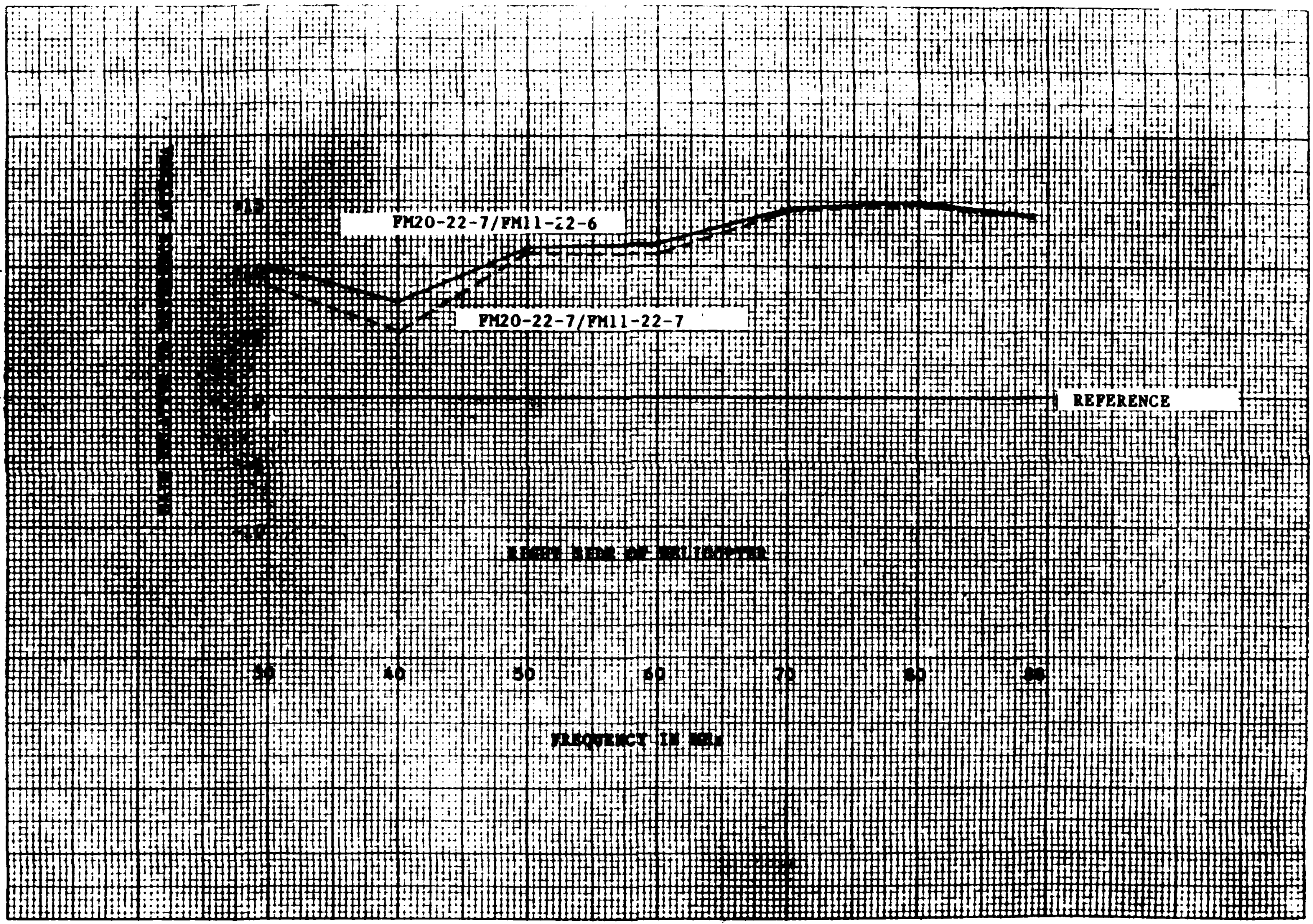
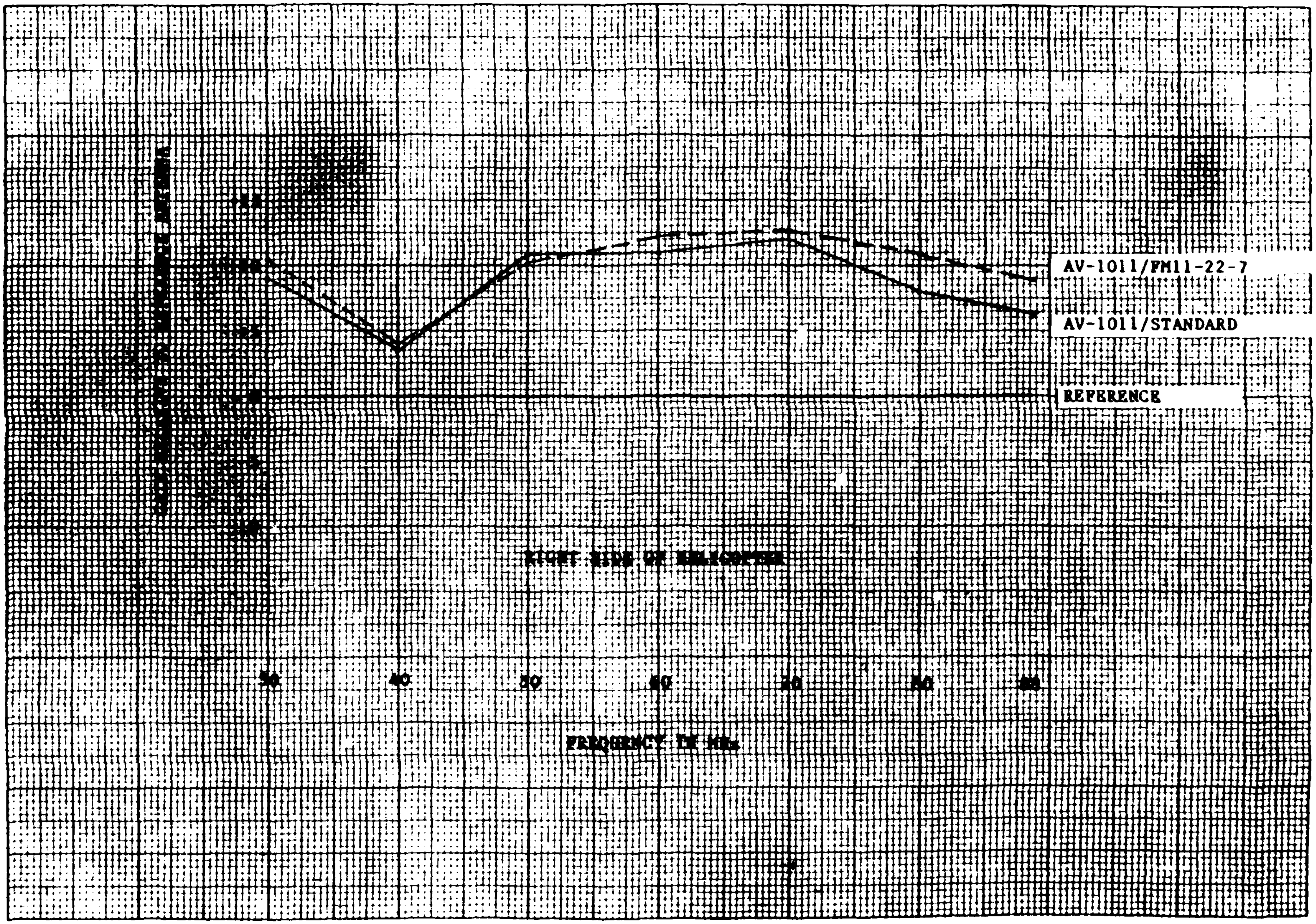
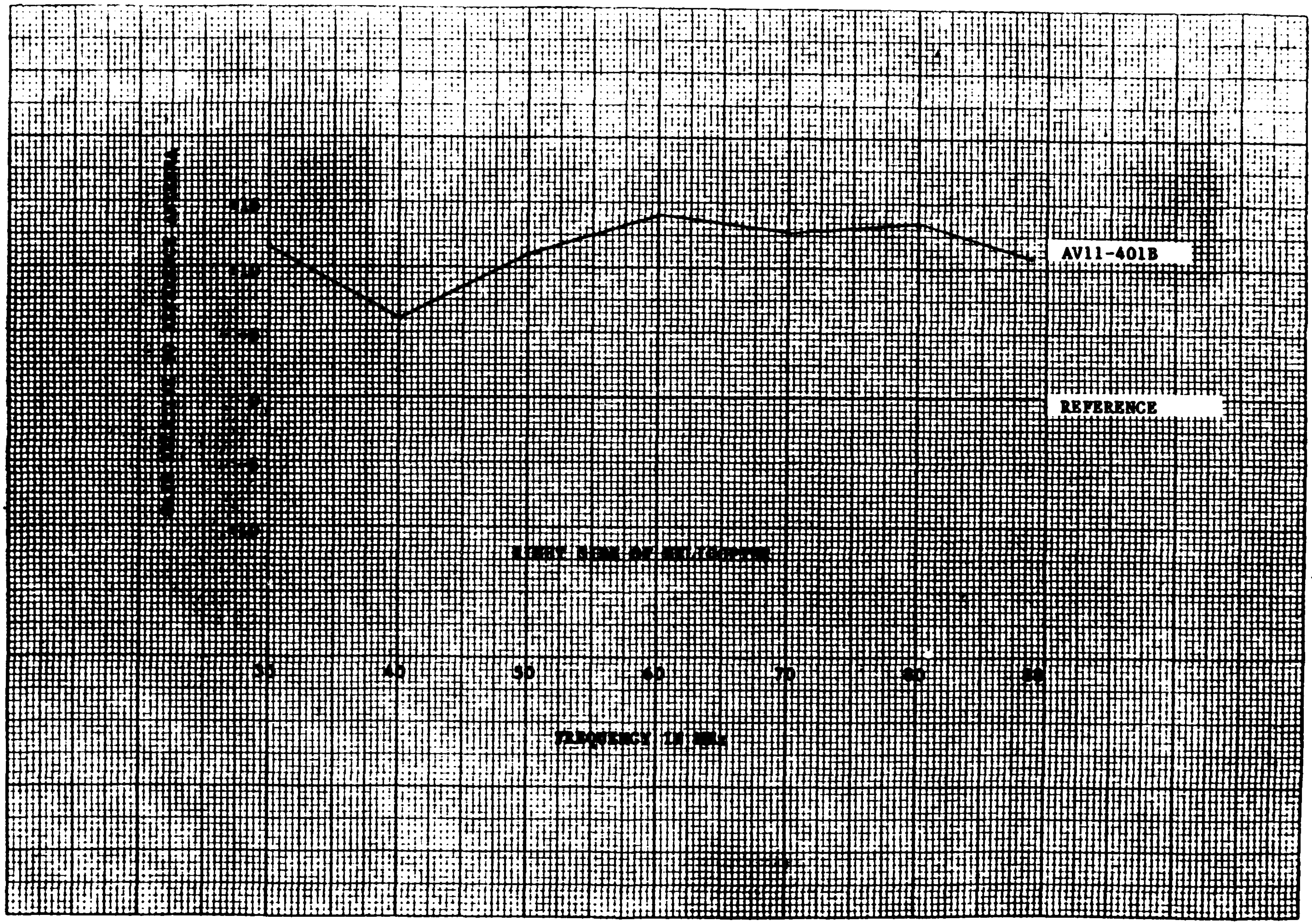
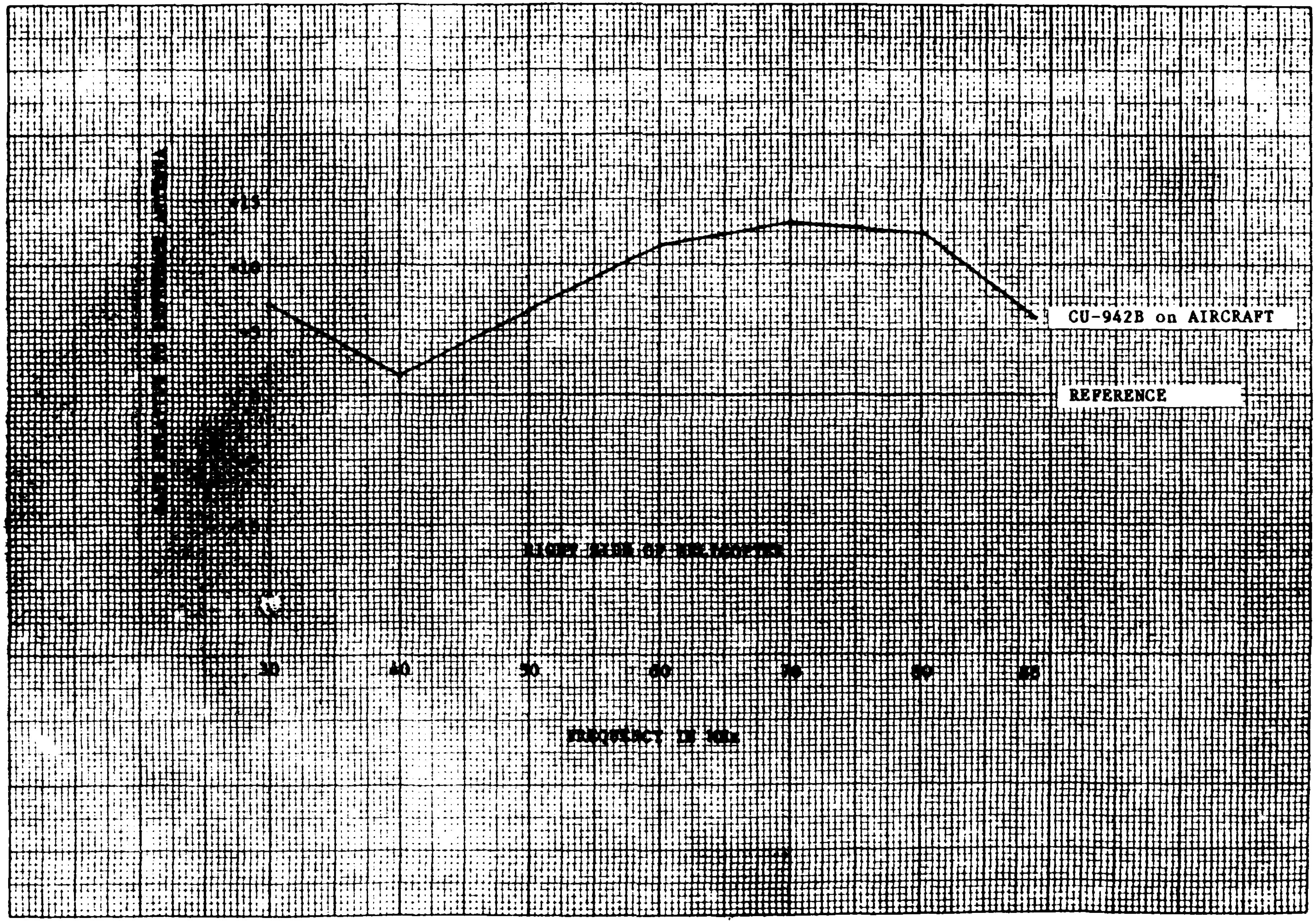
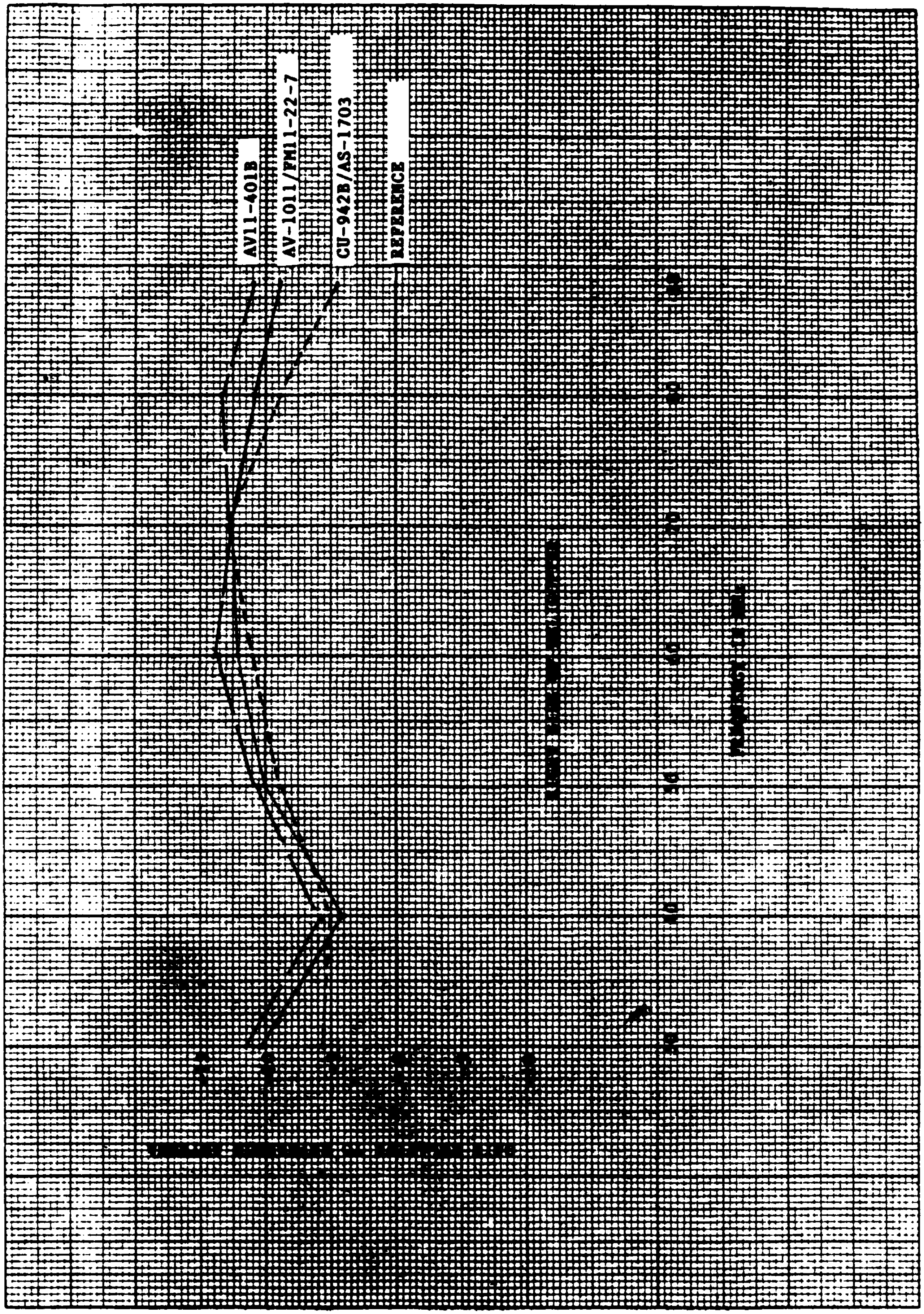

CU-942B/FM11-22-7
CU-942B/AS-1703
REFERENCE
RIGHT SIDE OF HELICOPTER
30
40
50
60
70
80
88
FREQUENCY IN MHz

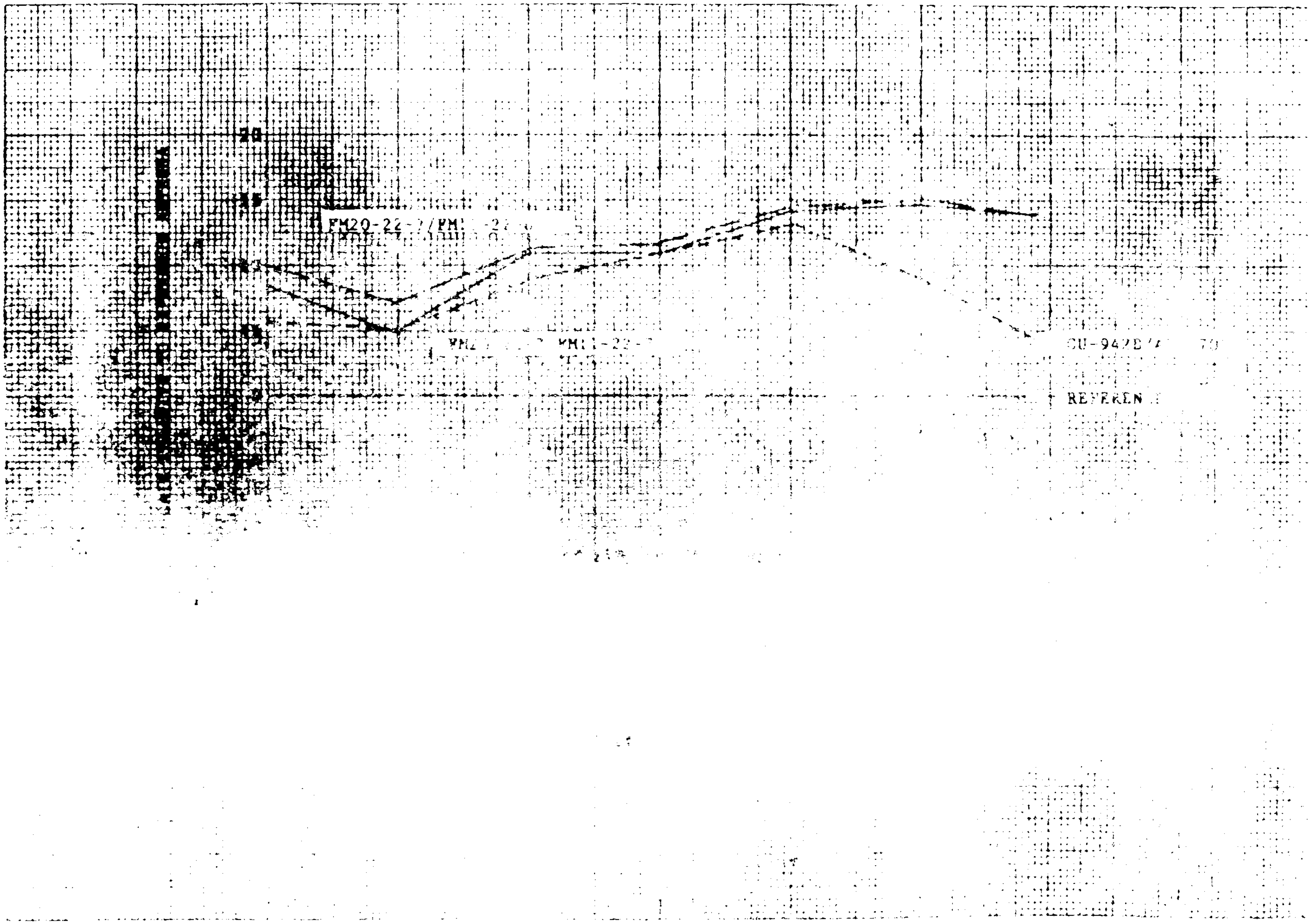

FM20-22-7/FM11-22-6
FM20-22-7/FM11-22-7
REFERENCE
30
40
50
60
70
80
90
FREQUENCY IN MHz


AV-1011/FM11-22-7
AV-1011/STANDARD
REFERENCE
RIGHT SIDE OF HELICOPTER
30
40
50
60
70
80
90
FREQUENCY IN MHz


AV11-401B
REFERENCE
30
40
50
60
70
80
90

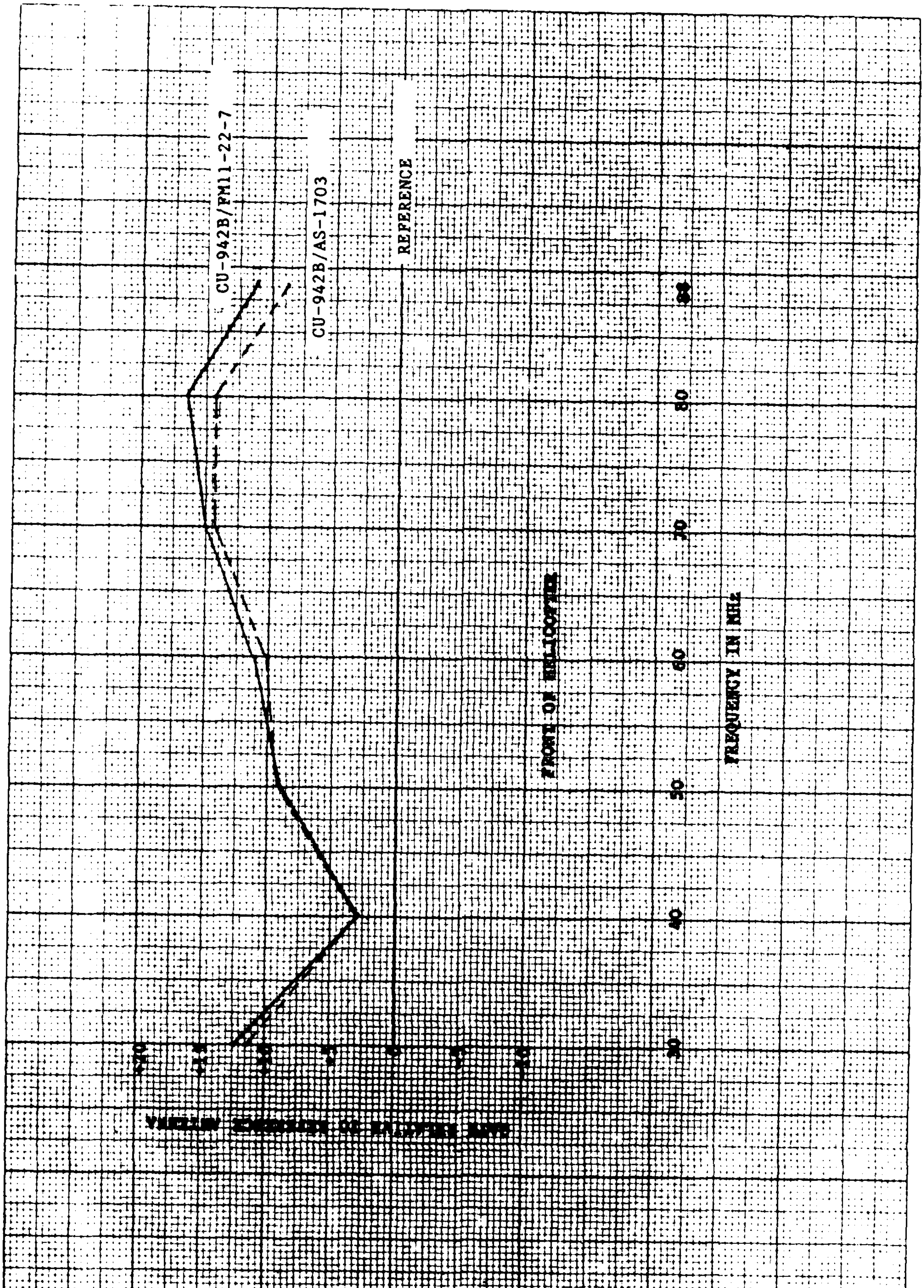

CU-942B on AIRCRAFT
REFERENCE
40
50
60

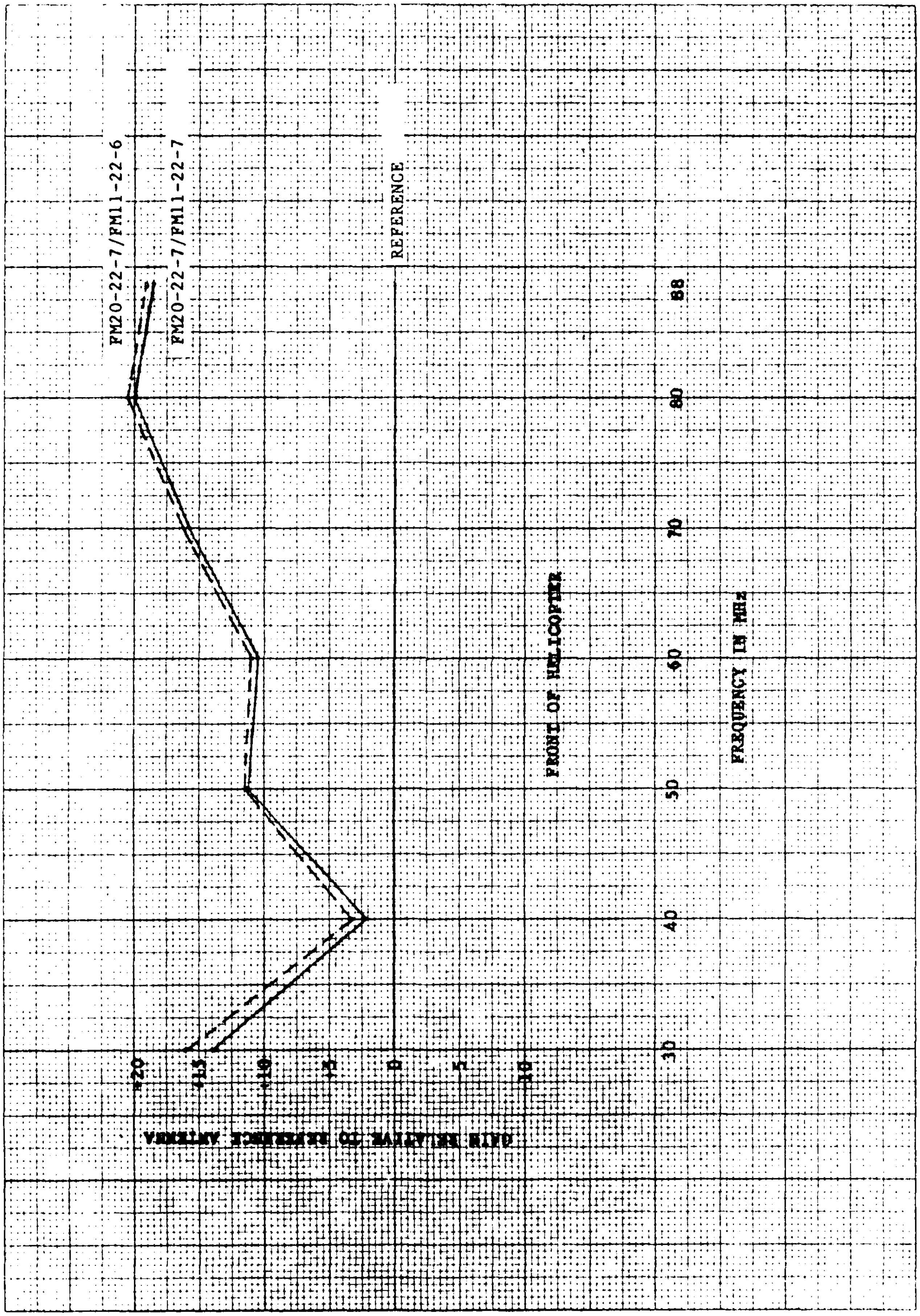

AV11-401B
AV-1011/FM11-22-7
CU-942B/AS-1703
REFERENCE

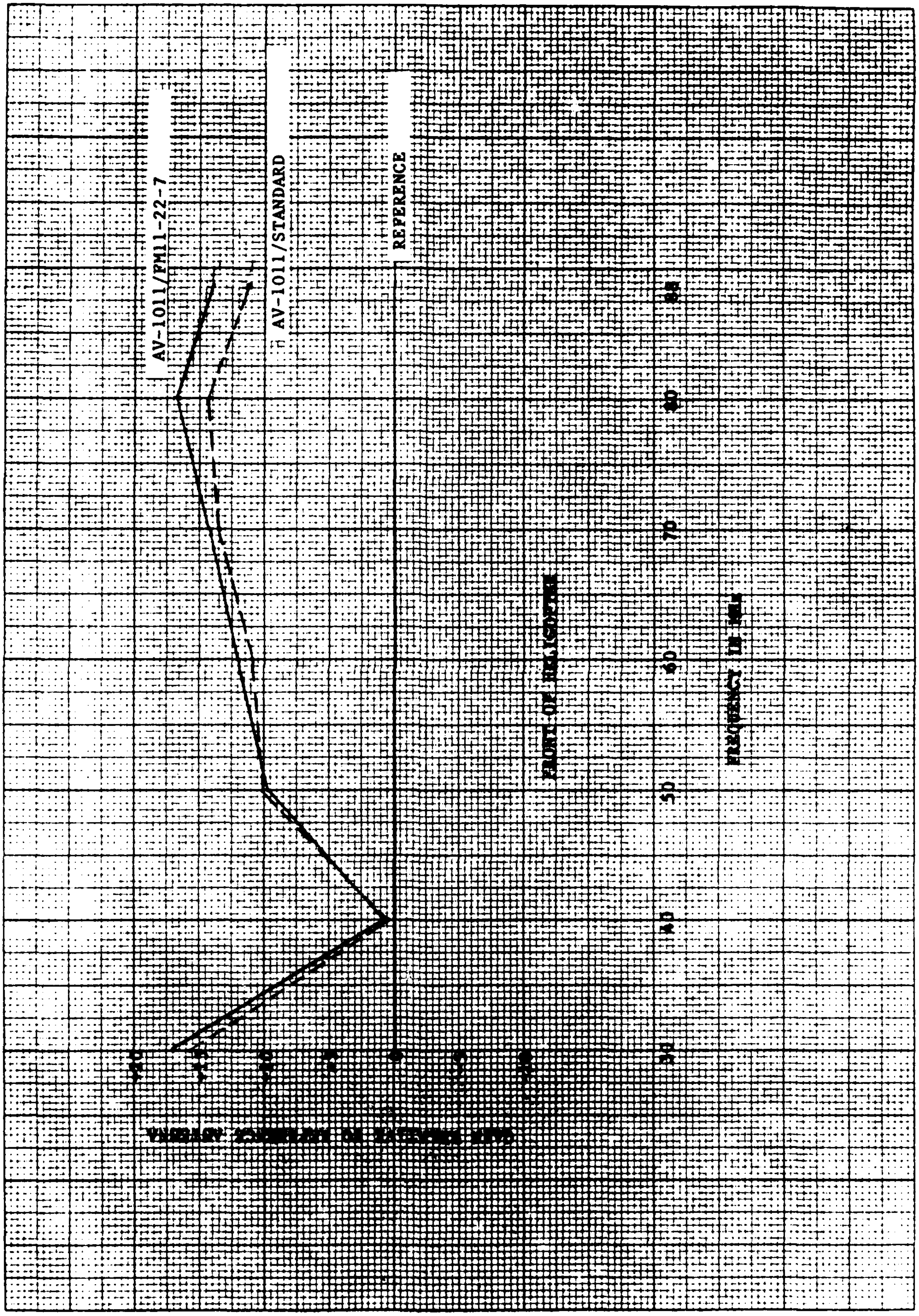


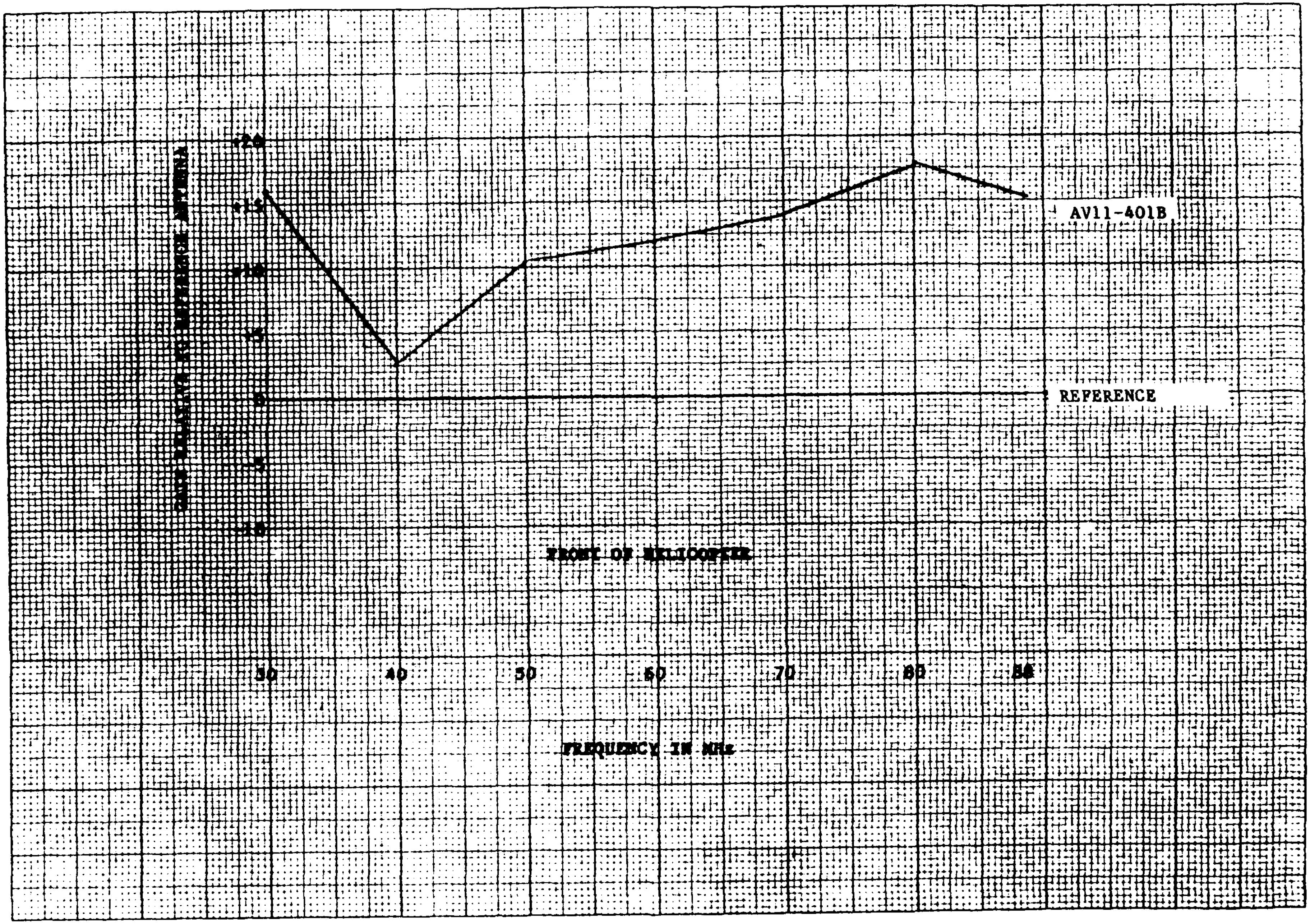
20
15
FM20-22-
REFEREN

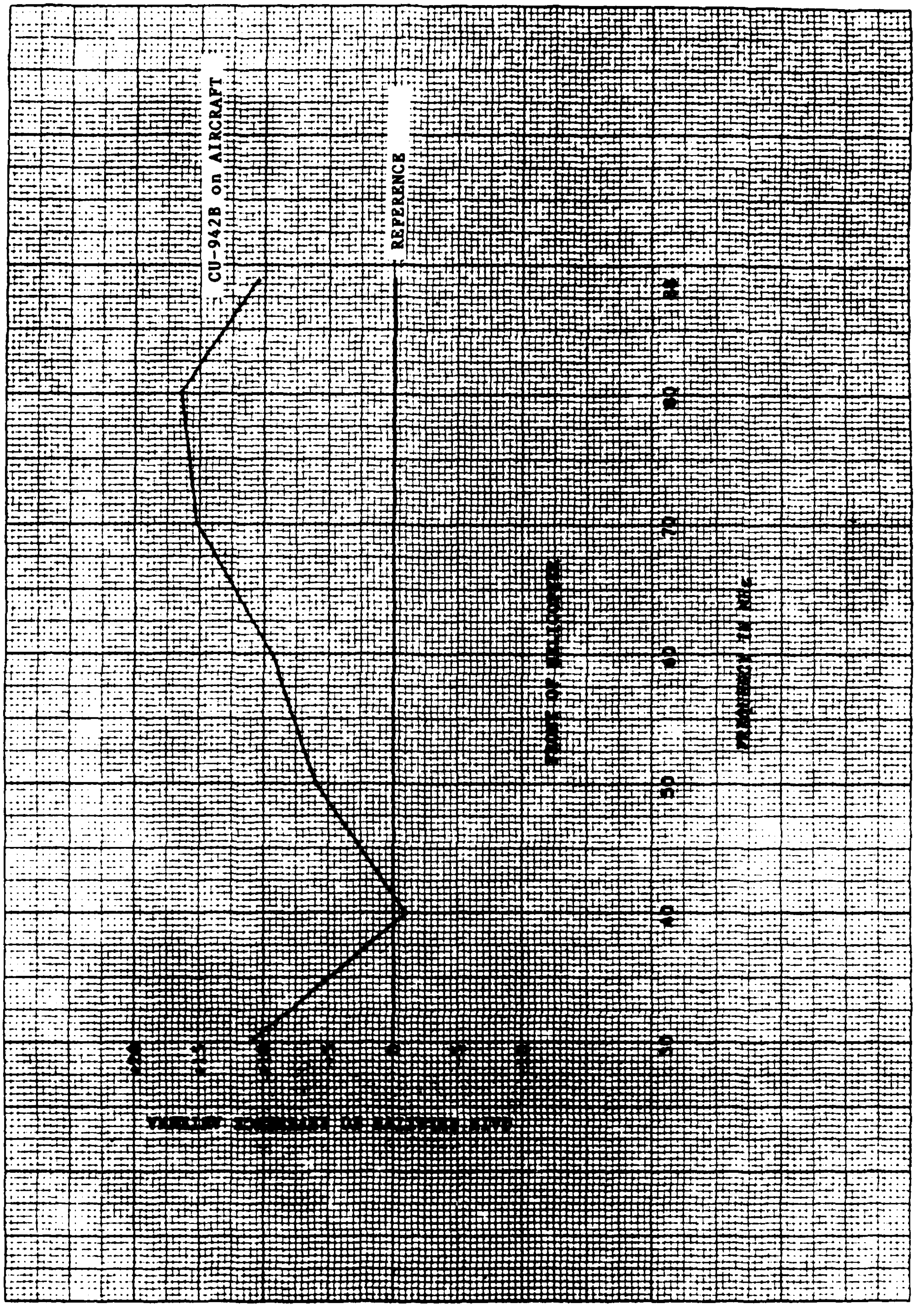
APPENDIX C. GAIN PLOTS - FRONT OF HELICOPTER

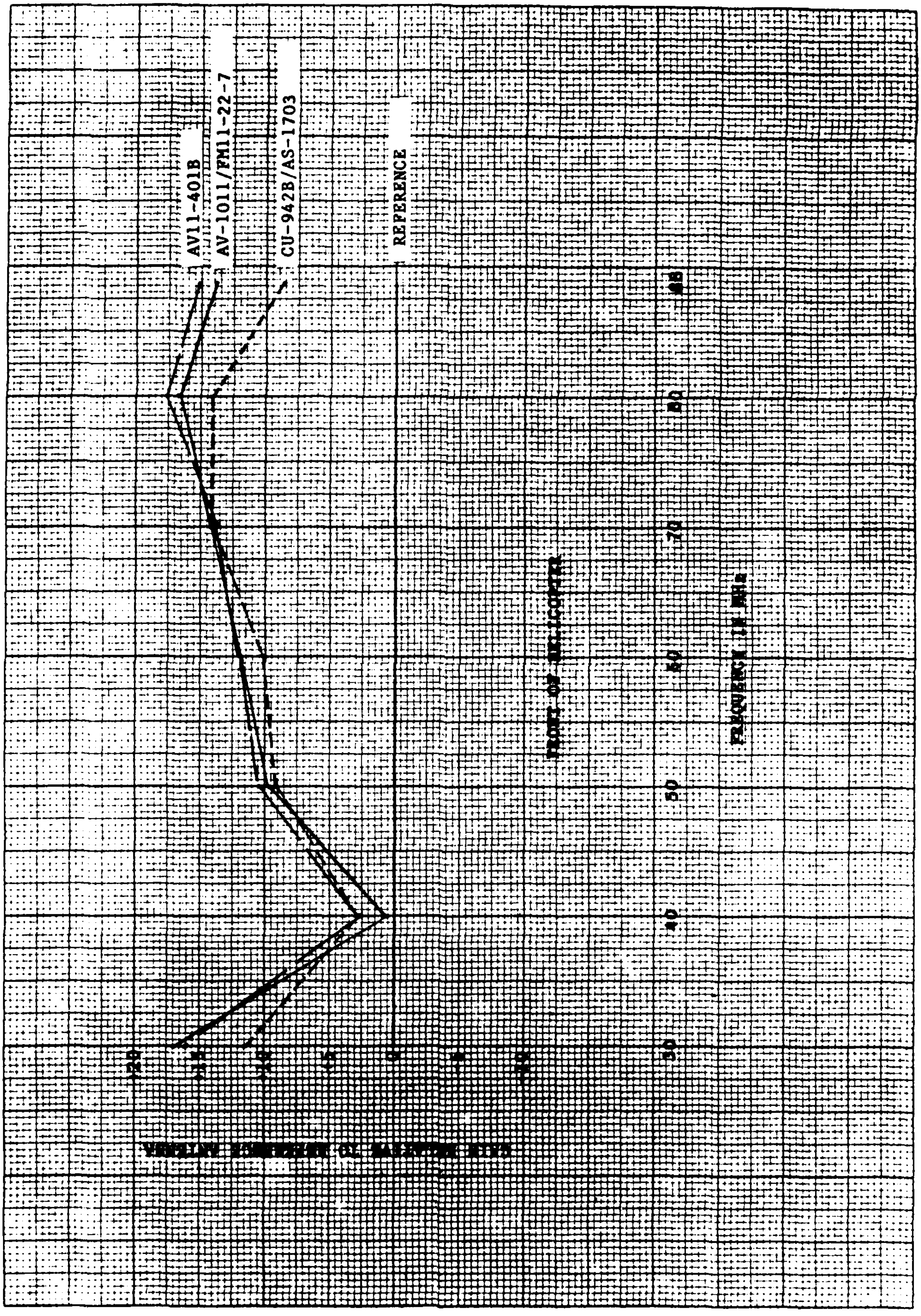

CU-942B/FM11-22-7
CU-942B/AS-1703
REFERENCE
FREQUENCY IN MHz
30
40
50
60
70
80
88

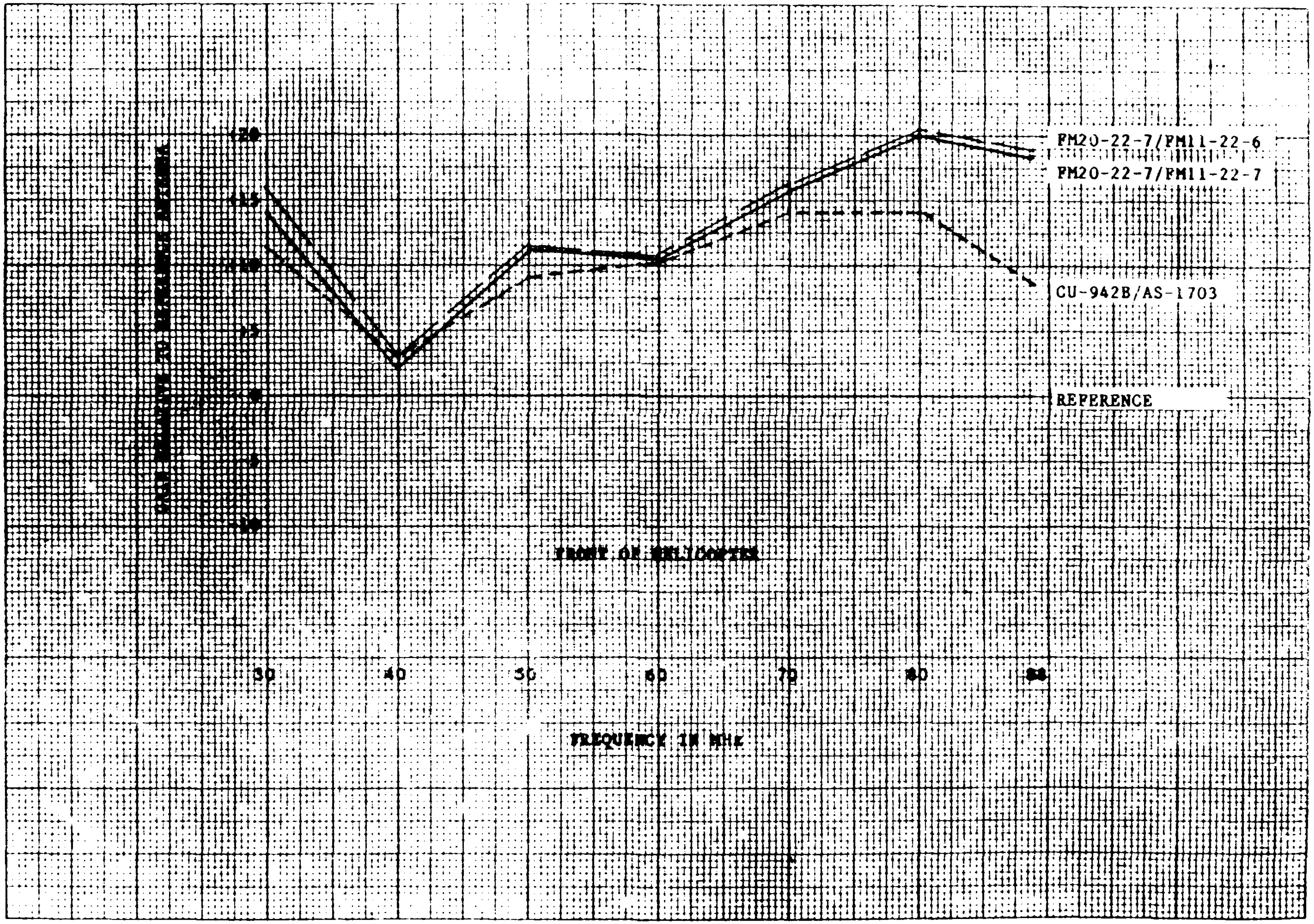

FM20-22-7/FM11-22-6
FM20-22-7/FM11-22-7
REFERENCE
FRONT OF HELICOPTER
FREQUENCY IN MHz
30
40
50
60
70
80
88
+20
+15
+10
+5
0
5
10


AV-1011/PM11-22-7
AV-1011/STANDARD
REFERENCE
30
40
50
60
70
80


AV11-401B
REFERENCE
30
40
50
60
70
80
FREQUENCY IN MHz


CU-942B on AIRCRAFT
REFERENCE


AV11-401B
AV-1011/FM11-22-7
CU-942B/AS-1703
REFERENCE
30
40
50
60
70
80
88



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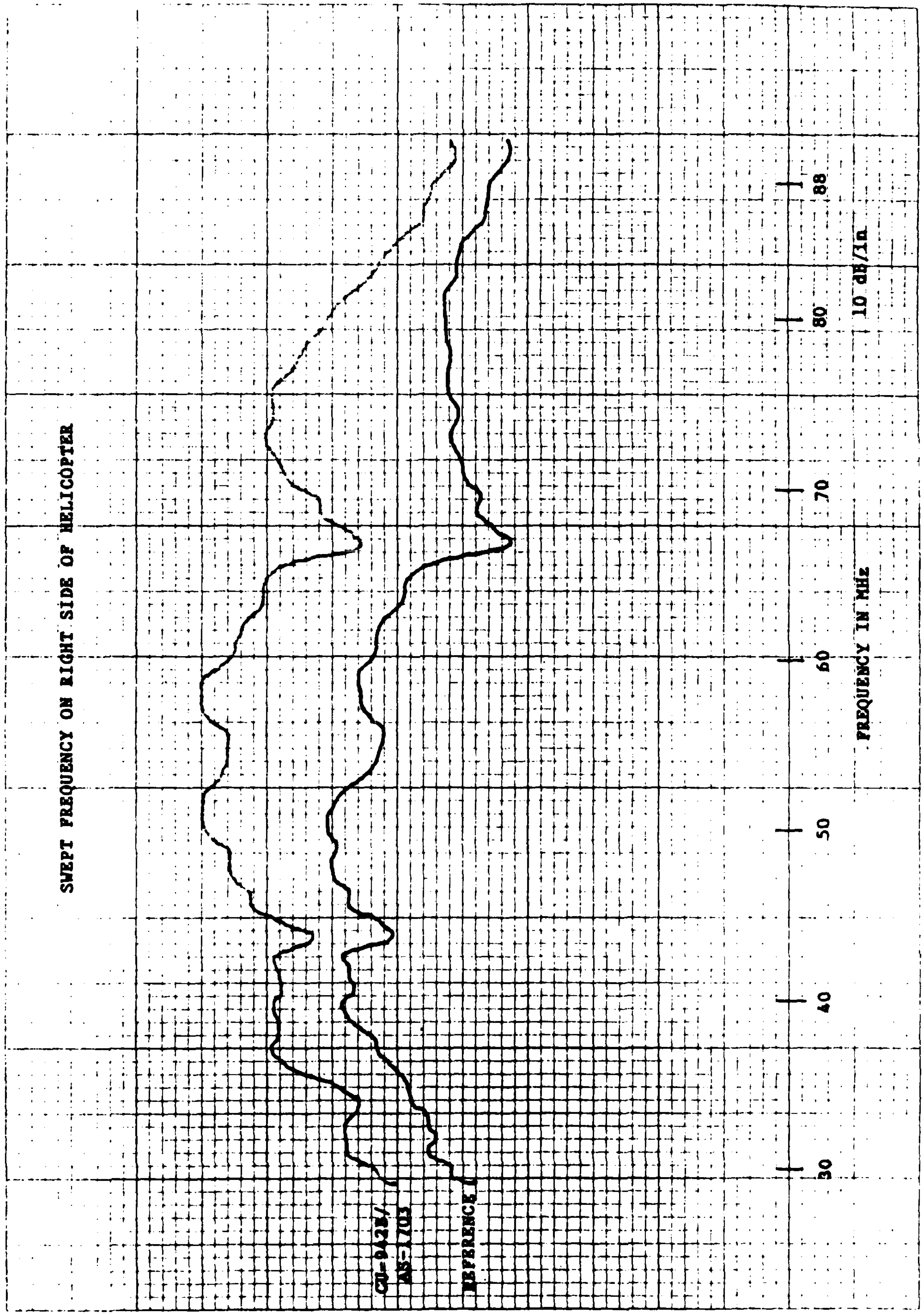
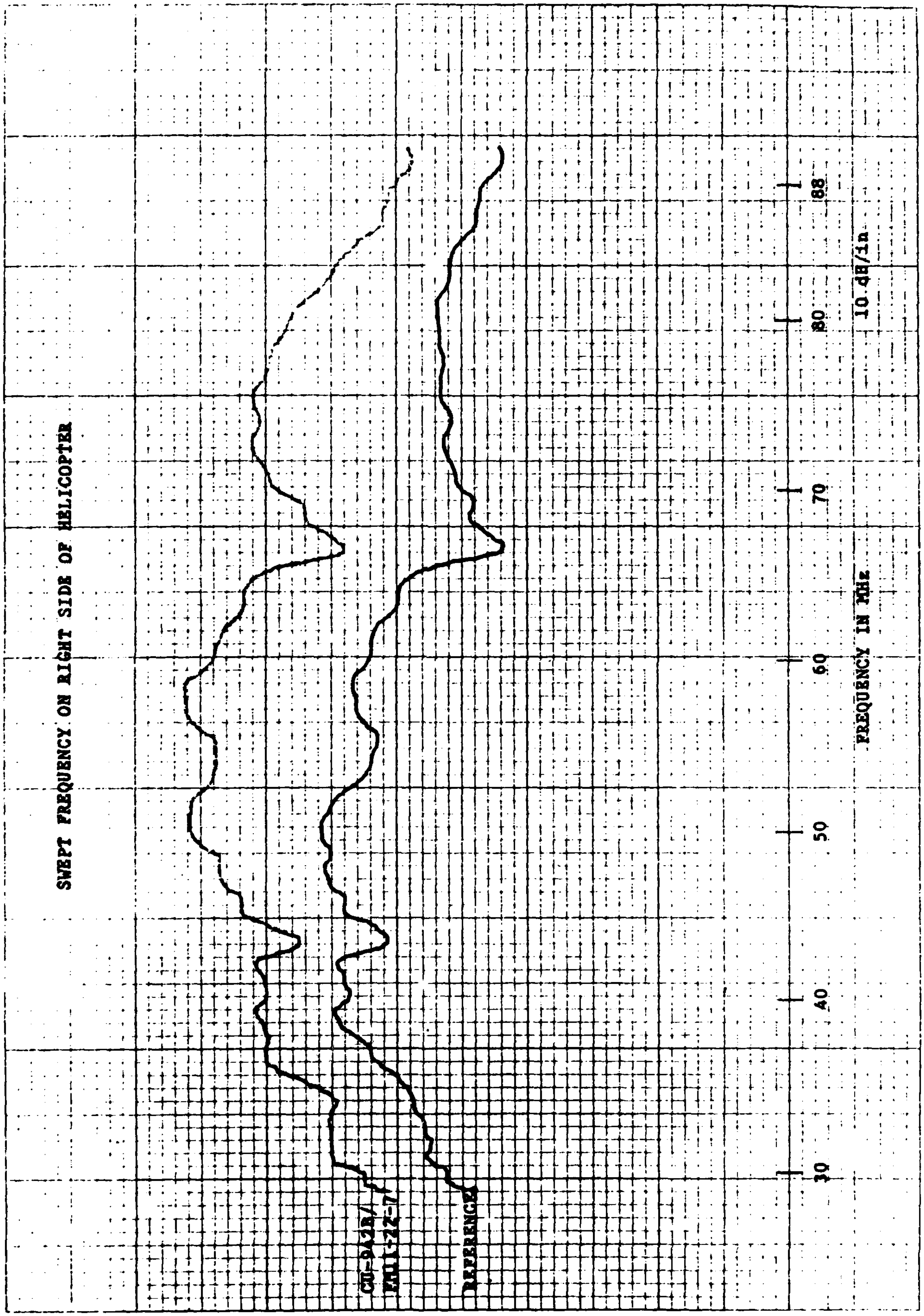
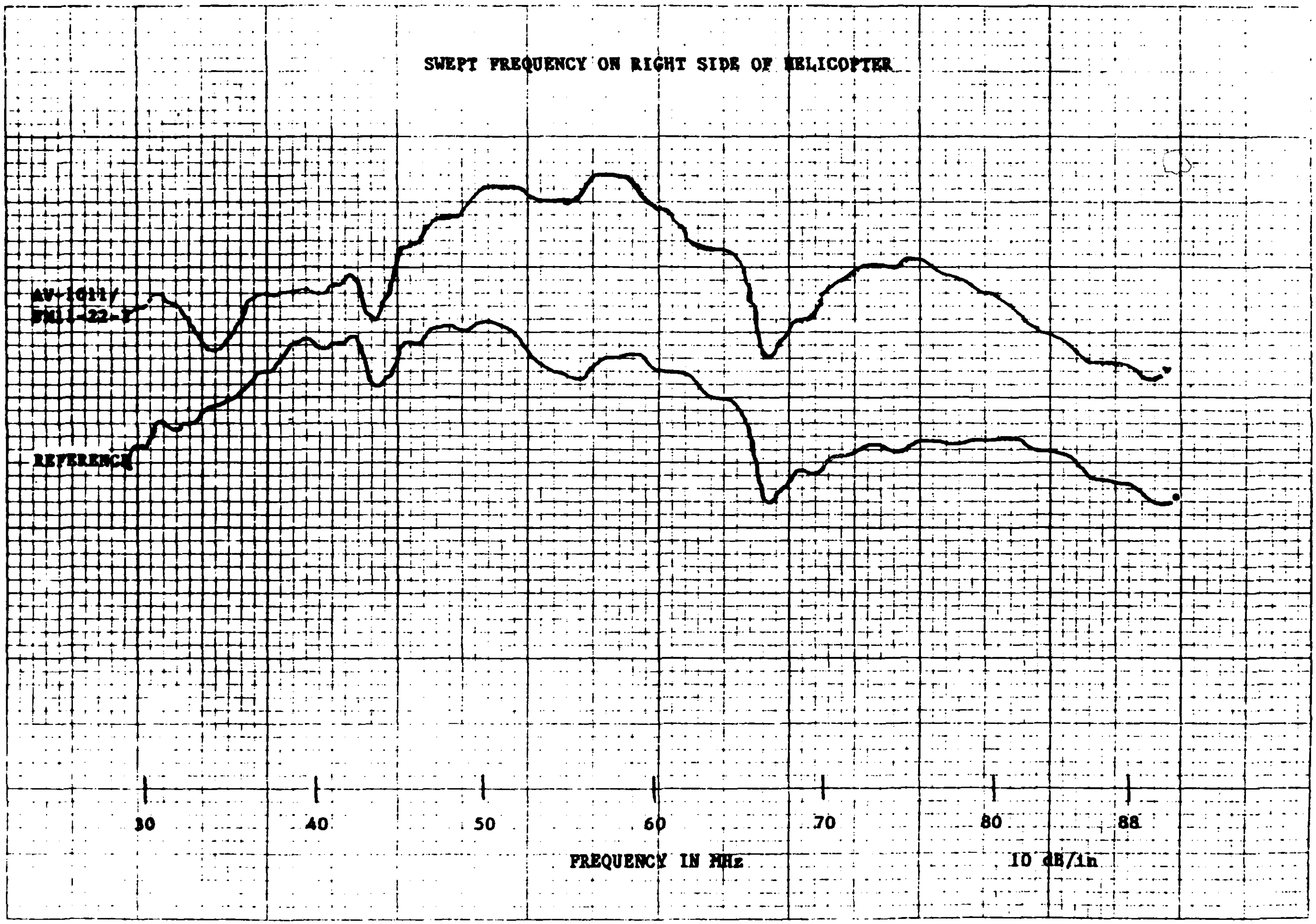
APPENDIX D. SWEPT FREQUENCY PATTERNS - RIGHT SIDE OF HELICOPTER

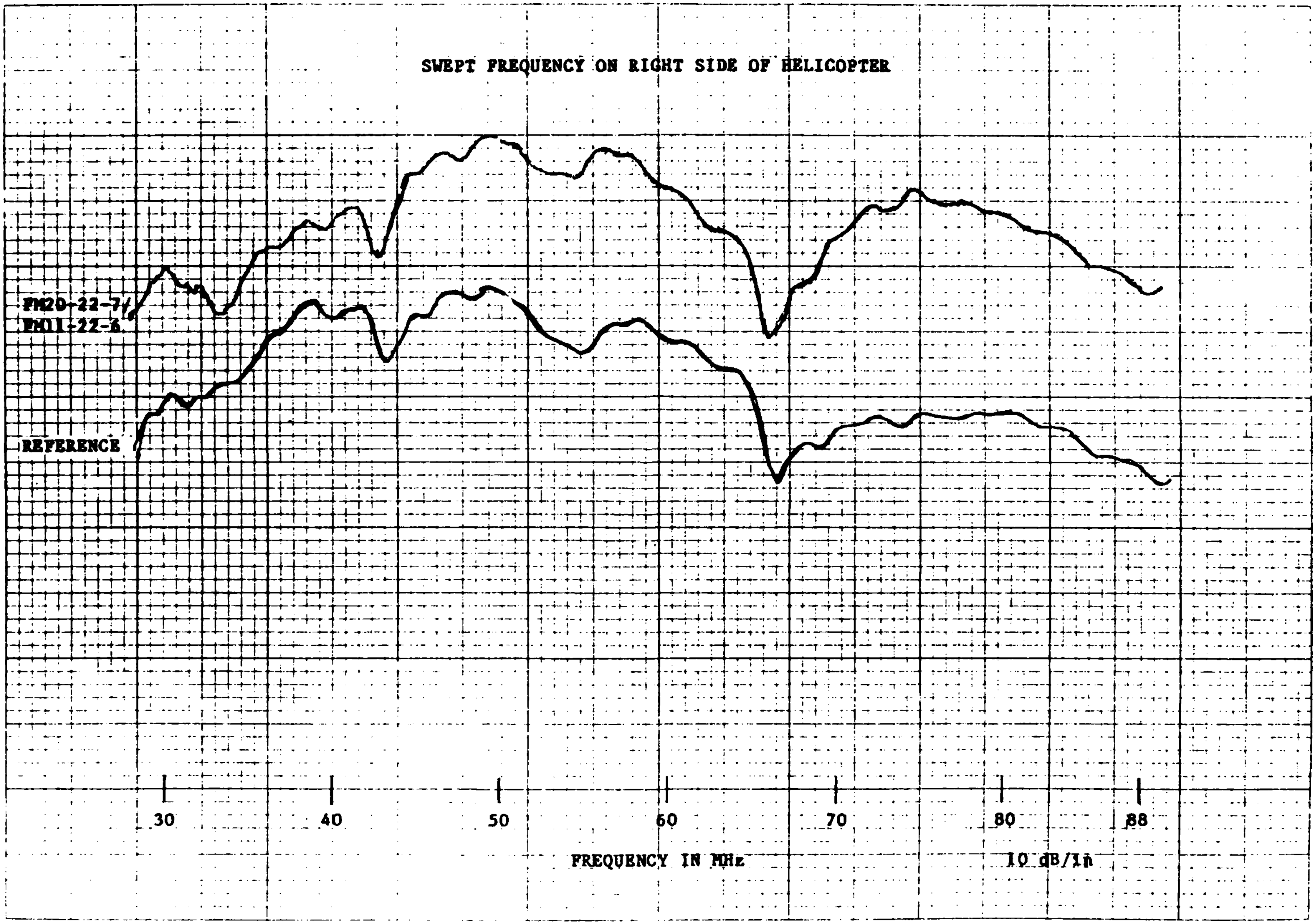
(page 62 is blank)



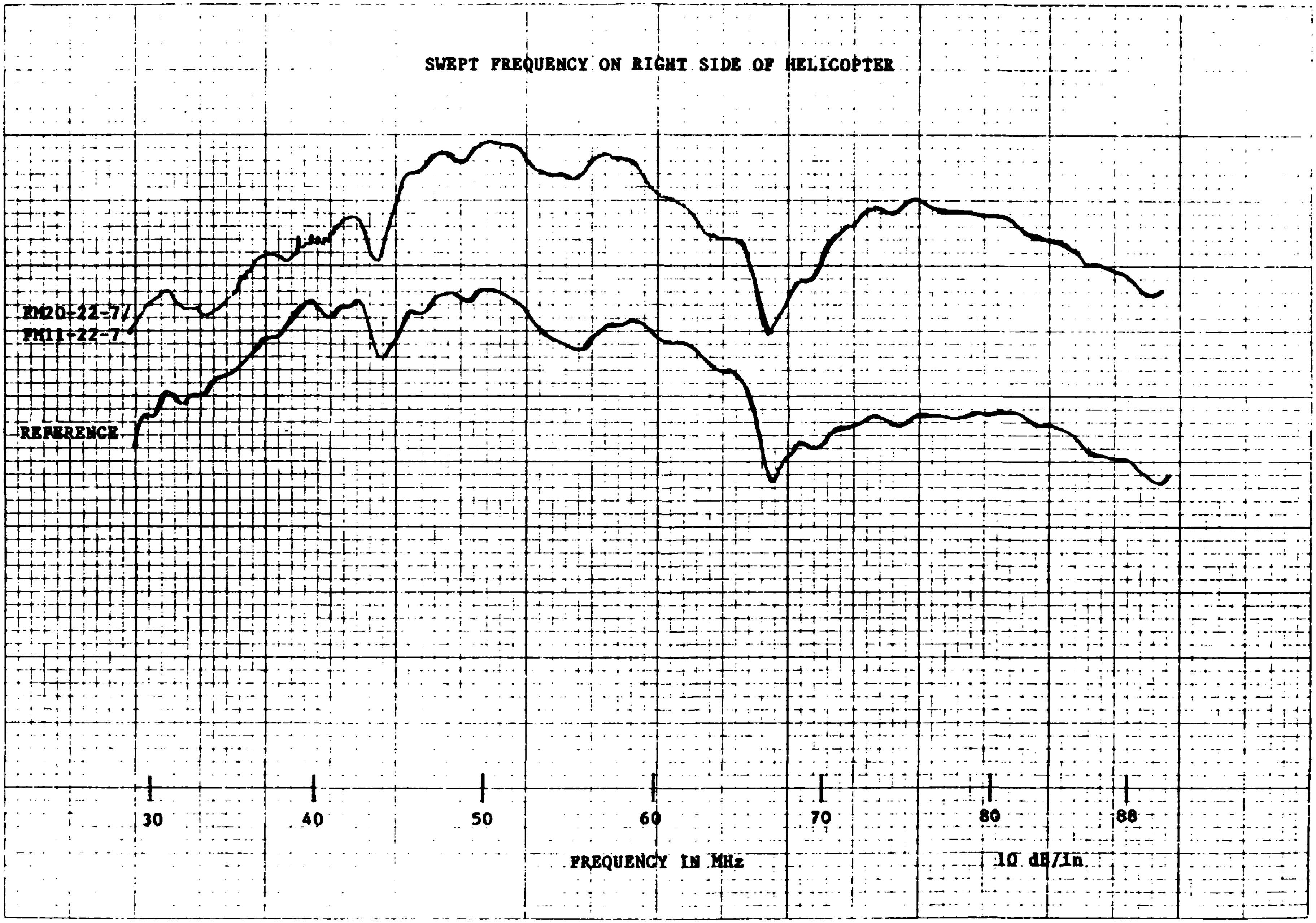
SWEPT FREQUENCY ON RIGHT SIDE OF HELICOPTER
CU-942B/
AS-1703
REFERENCE
30
40
50
60
70
80
88
10 dB/in
FREQUENCY IN MHz

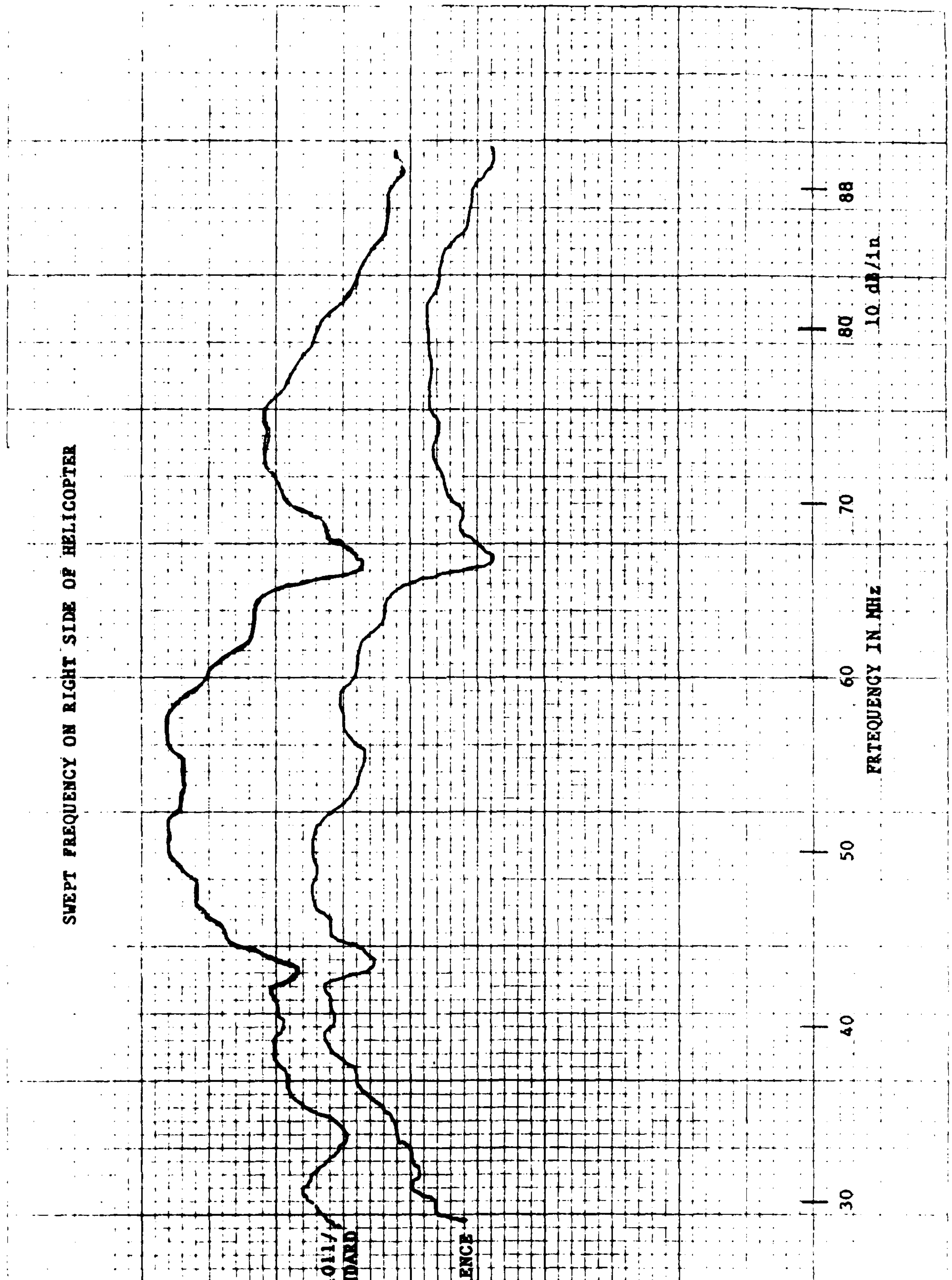

SWEPT FREQUENCY ON RIGHT SIDE OF HELICOPTER
CU-942B/
REFERENCE
30
40
50
60
70
80
88
FREQUENCY IN MHz
10 dB/in

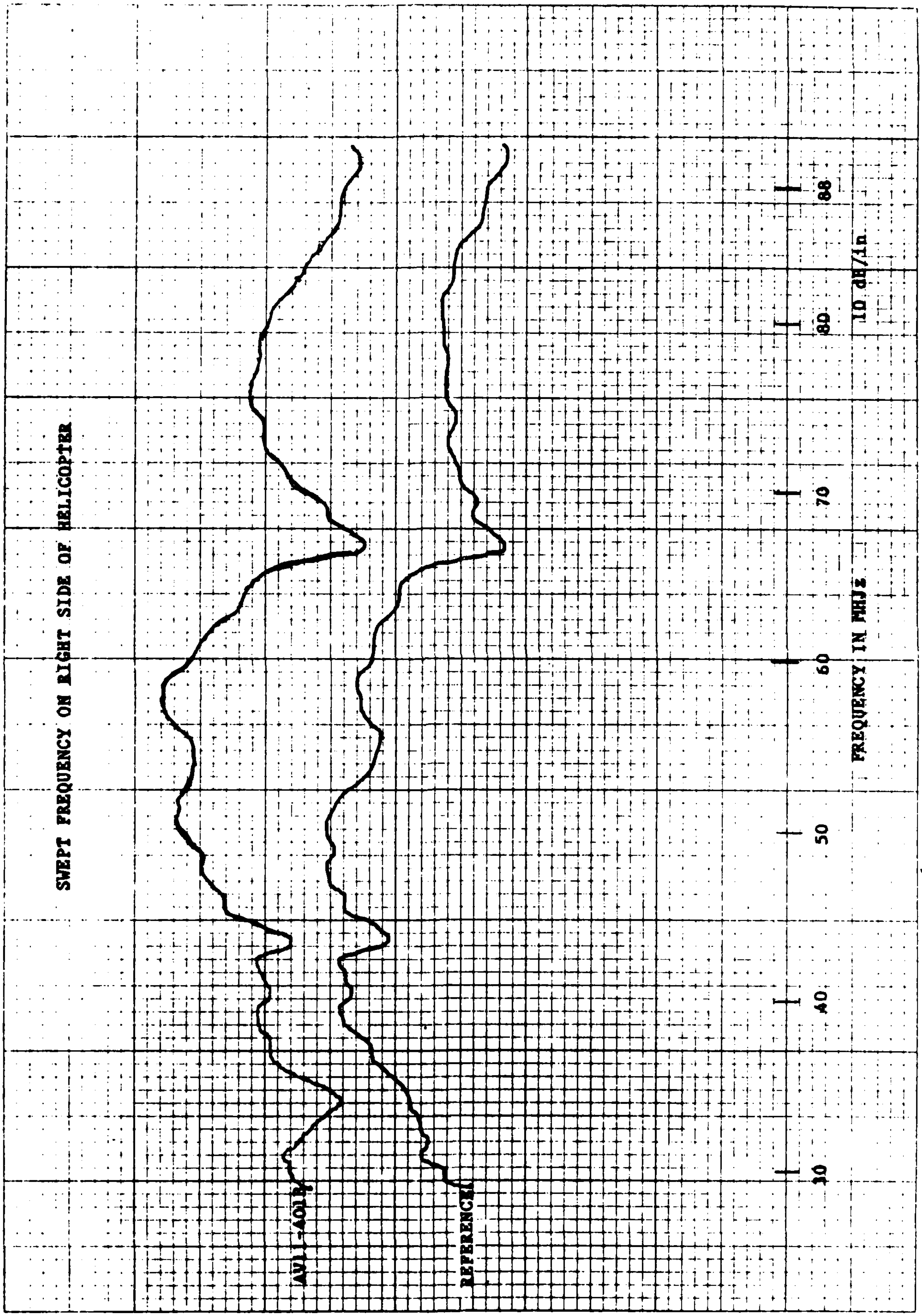

SWEPT FREQUENCY ON RIGHT SIDE OF HELICOPTER
REFERENCE
30
40
50
60
70
80
88
FREQUENCY IN MHz
10 dB/in



SWEPT FREQUENCY ON RIGHT SIDE OF HELICOPTER
FM20-22-7/
FM11-22-6
REFERENCE
30
40
50
60
70
80
88
FREQUENCY IN MHz
10 dB/in

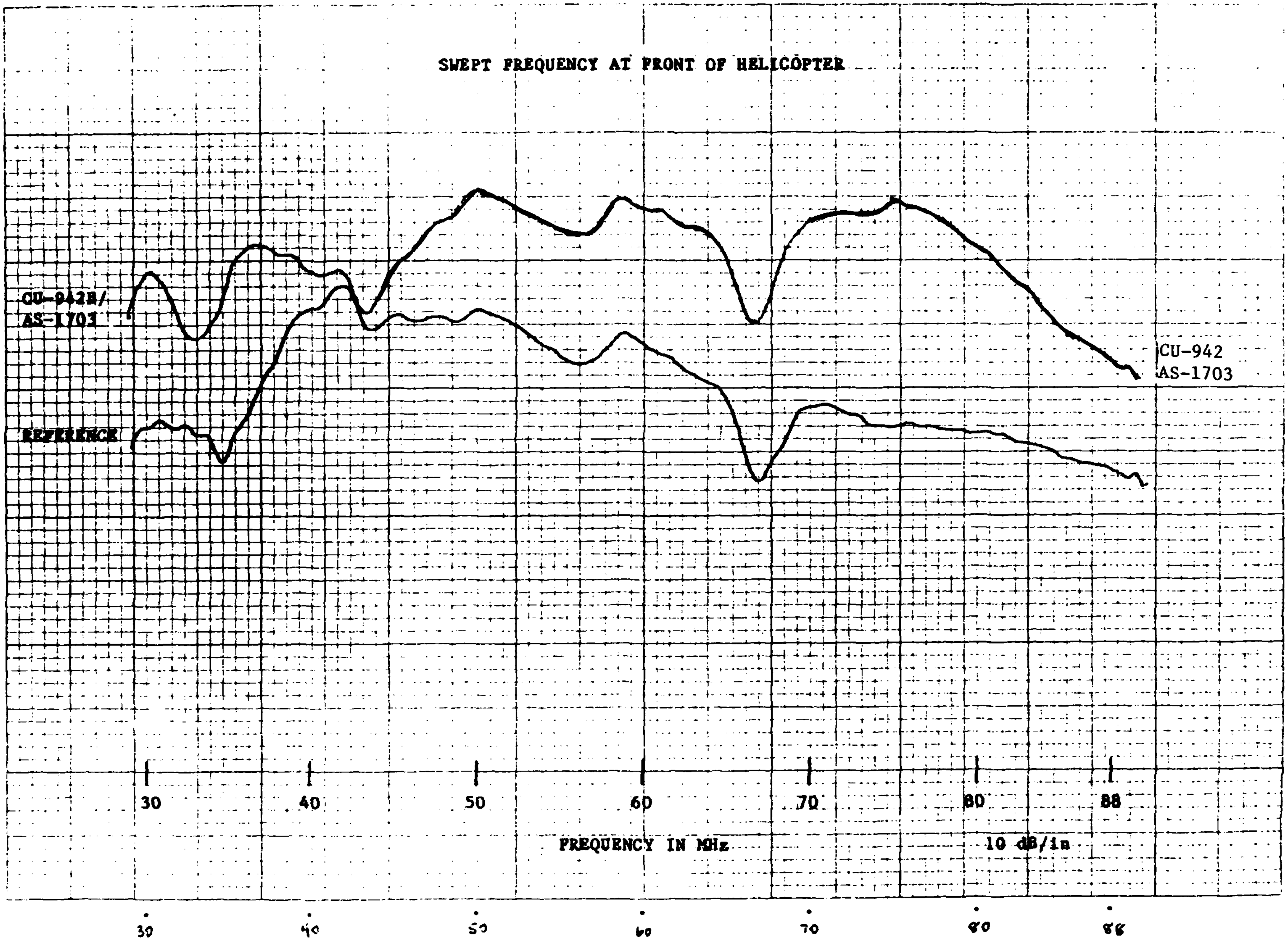

SWEPT FREQUENCY ON RIGHT SIDE OF HELICOPTER
FM20-22-7/
FM11-22-7
REFERENCE
30
40
50
60
70
80
88
FREQUENCY IN MHz
10 dB/in

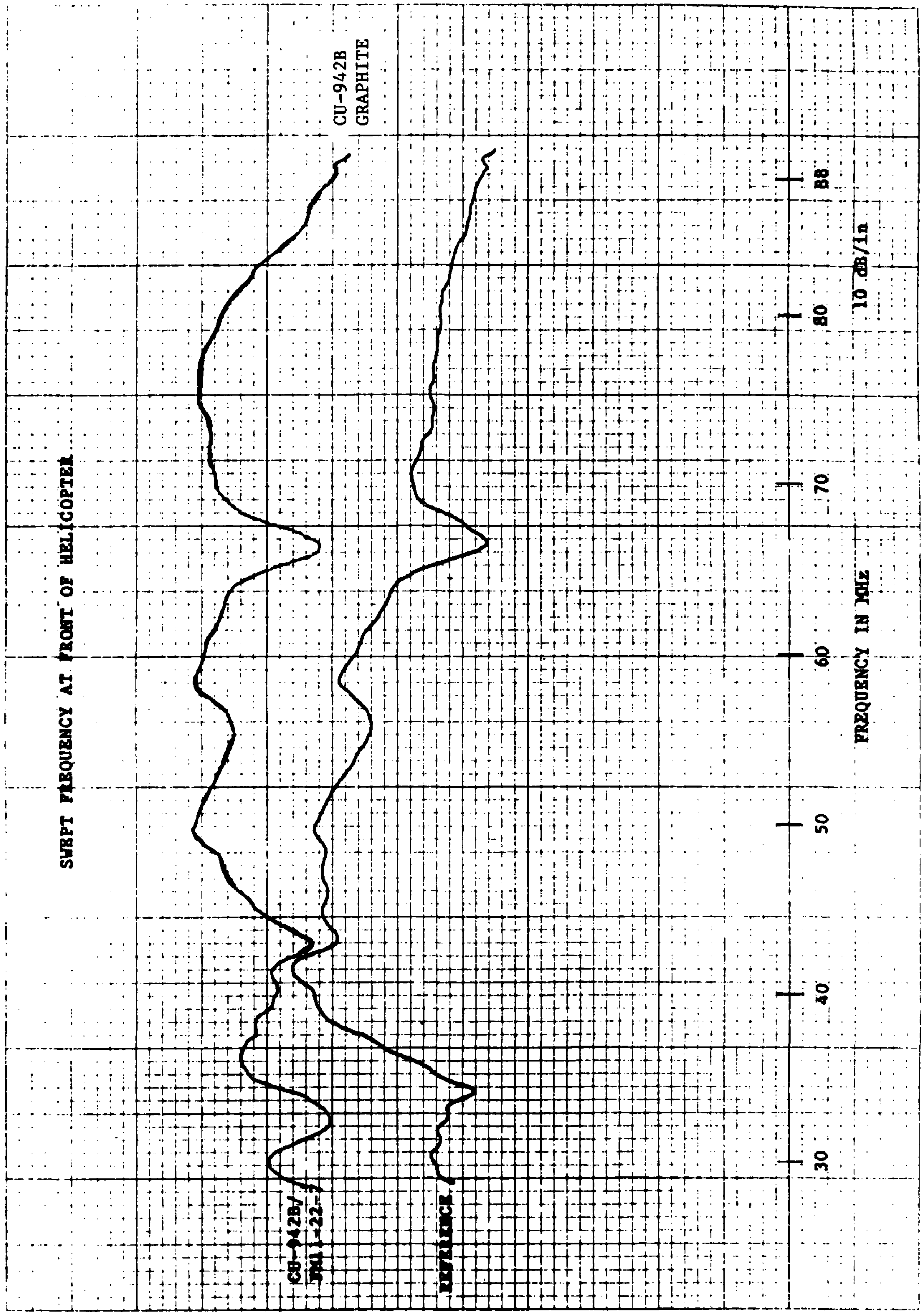

SWEPT FREQUENCY ON RIGHT SIDE OF HELICOPTER
AV-1011/ STANDARD
REFERENCE
30
40
50
60
70
80
88
FREQUENCY IN MHz
10 dB/in

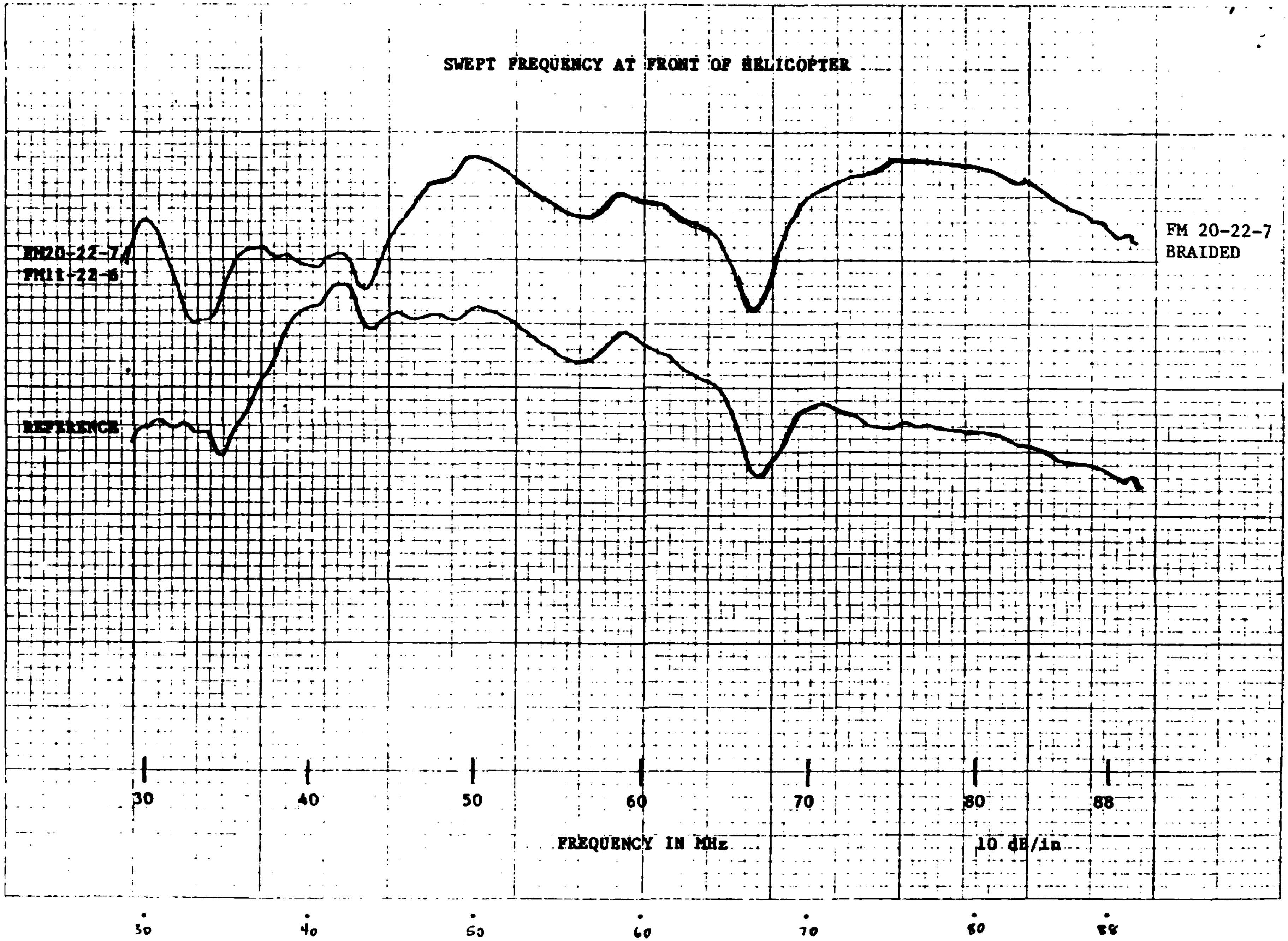

SWEPT FREQUENCY ON RIGHT SIDE OF HELICOPTER
AV11-A01B
REFERENCE
30
40
50
60
70
80
88
FREQUENCY IN MHz
10 dB/in

APPENDIX E. SWEPT FREQUENCY PATTERNS - FRONT OF HELICOPTER

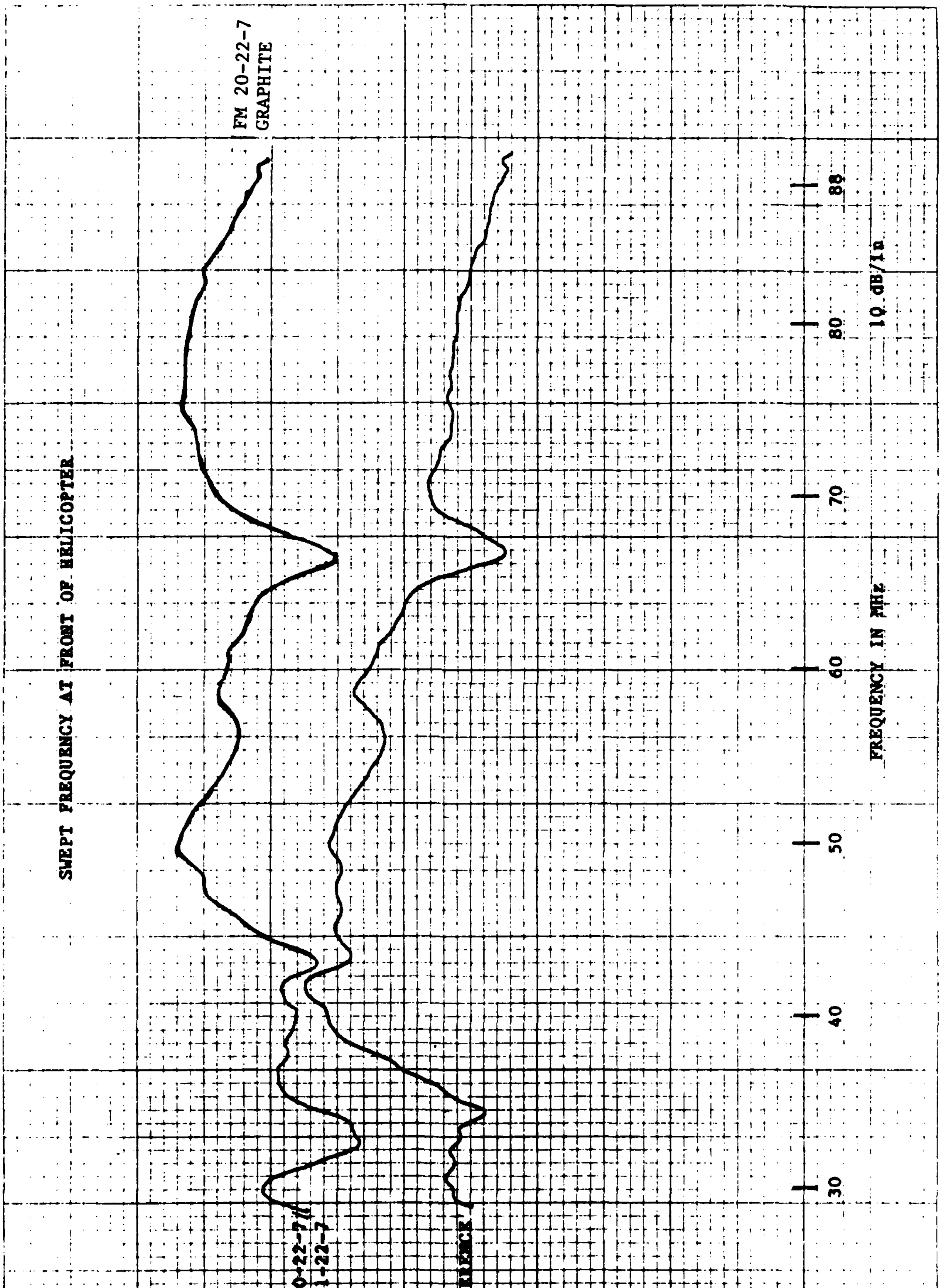
(page 72 is blank)

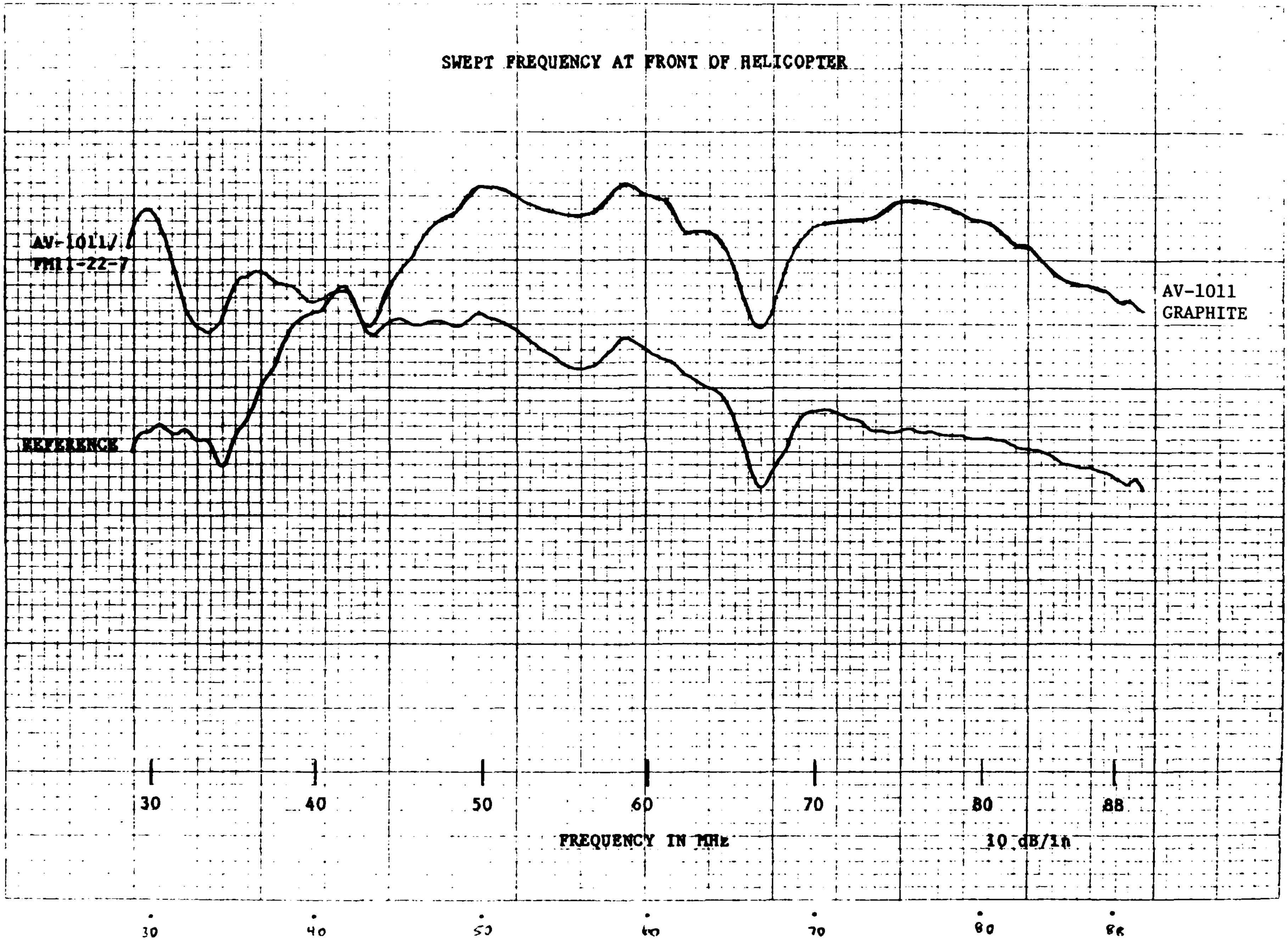

SWEPT FREQUENCY AT FRONT OF HELICOPTER
CU-942B/
AS-1703
REFERENCE
CU-942
AS-1703
30
40
50
60
70
80
88
FREQUENCY IN MHz
10 dB/in


SWEPT FREQUENCY AT FRONT OF HELICOPTER
CU-942B
GRAPHITE
REFERENCE
FREQUENCY IN MHz
10 dB/in
30
40
50
60
70
80
88

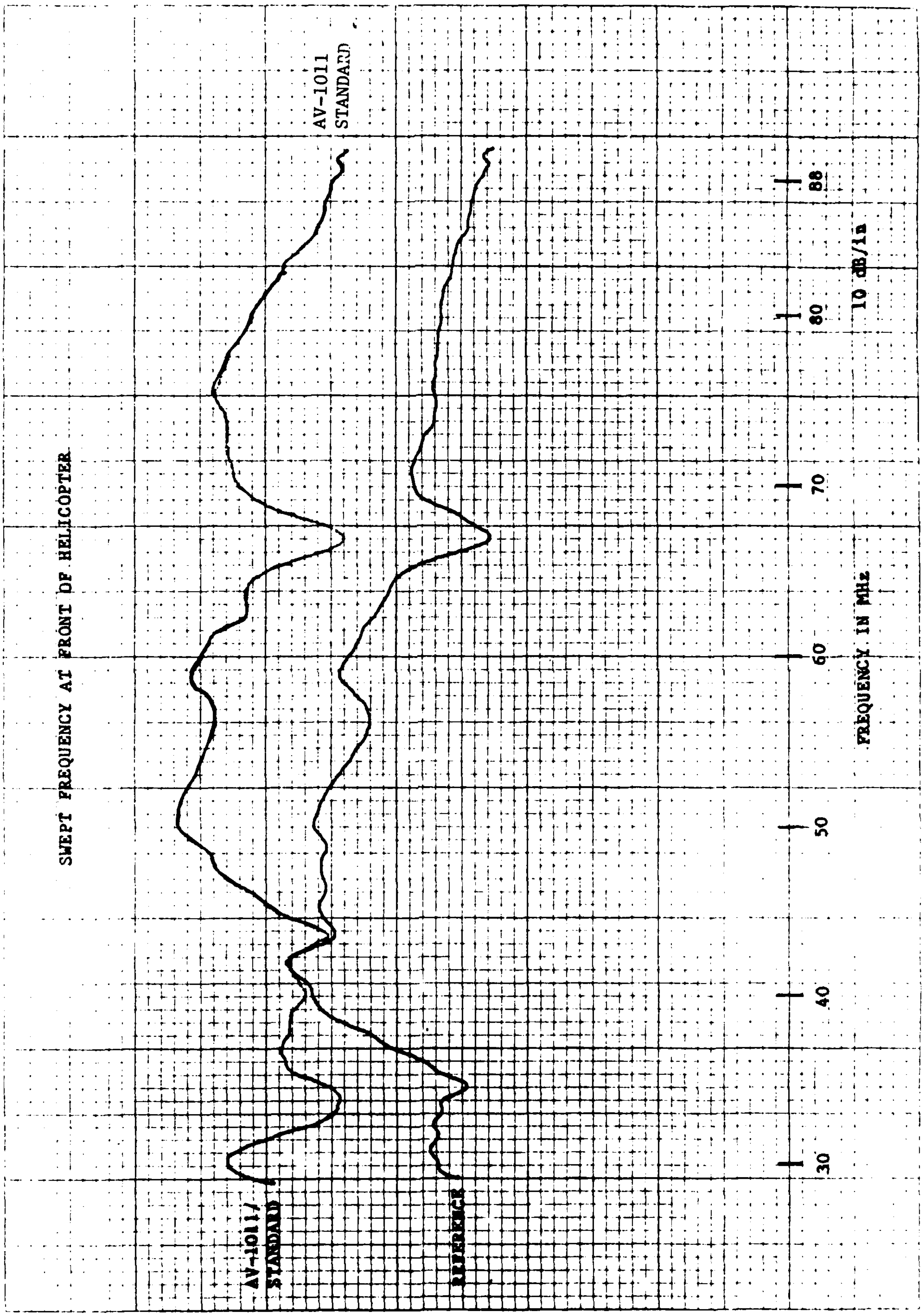


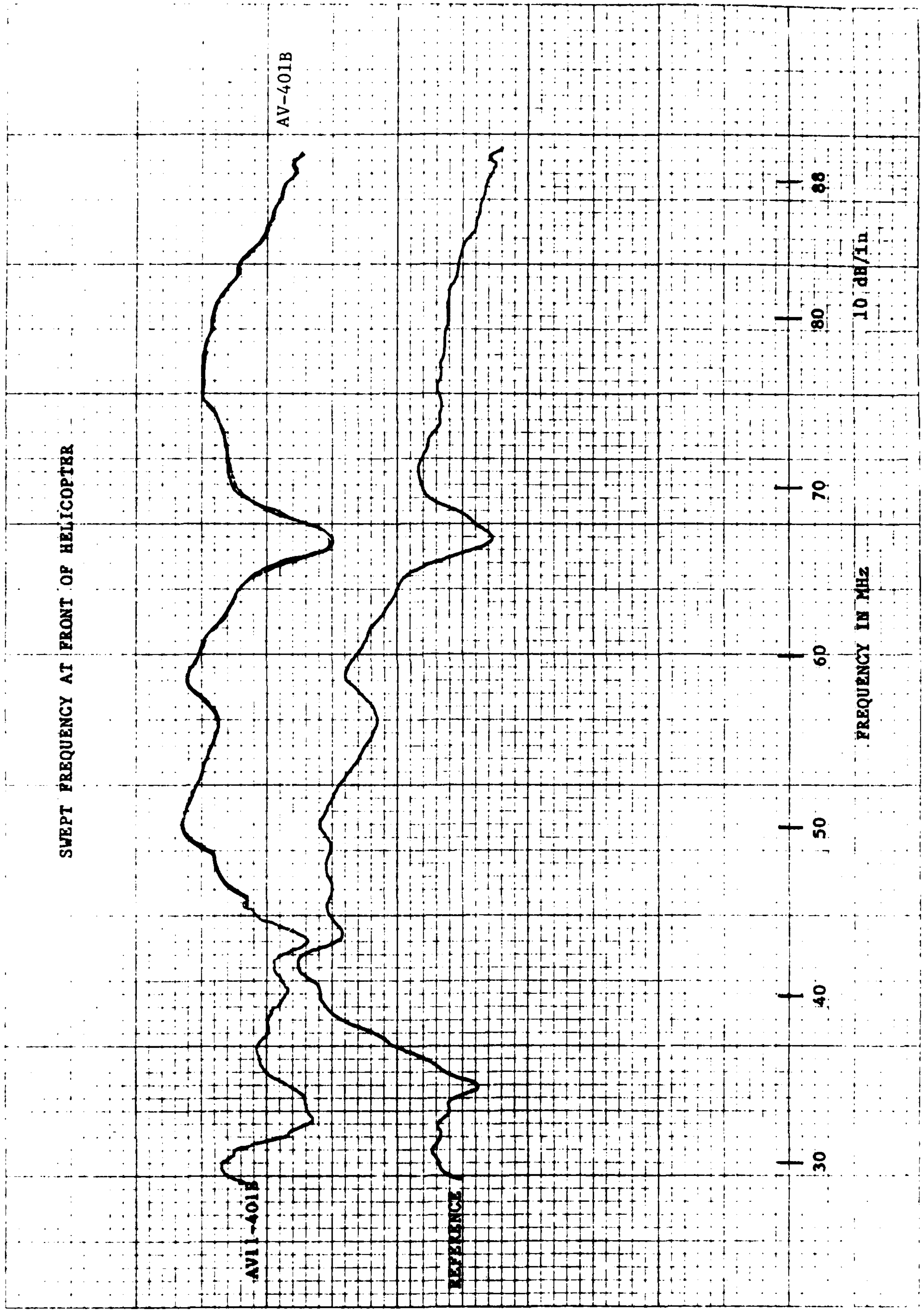
SWEPT FREQUENCY AT FRONT OF HELICOPTER
FM20-22-7
FM11-22-6
REFERENCE
FM 20-22-7
BRAIDED
30
40
50
60
70
80
88
FREQUENCY IN MHz
10 dB/in

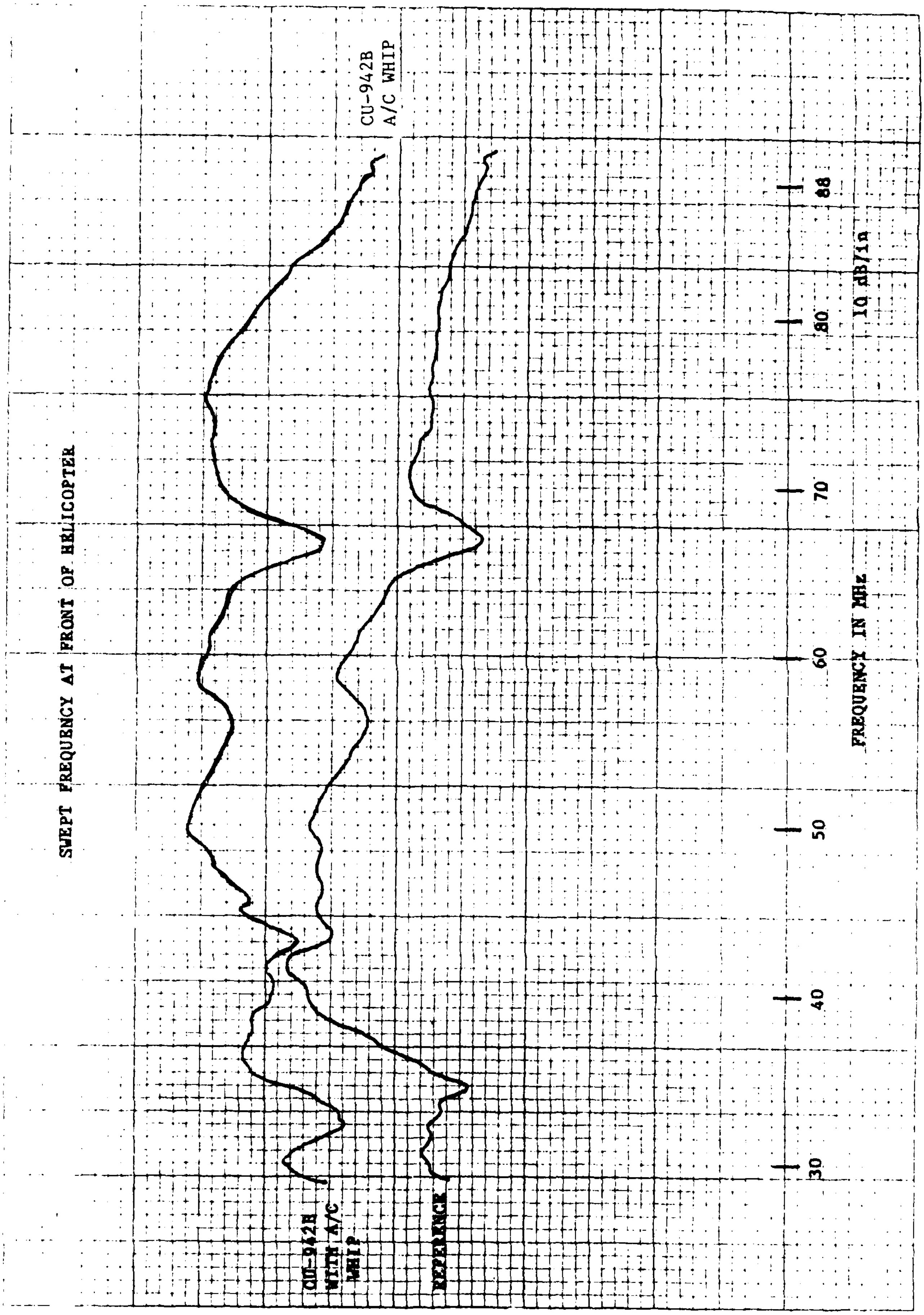

SWEPT FREQUENCY AT FRONT OF HELICOPTER
FM 20-22-7
GRAPHITE
FM20-22-7
FM11-22-7
REFERENCE
30
40
50
60
70
80
88
10 dB/in
FREQUENCY IN MHz

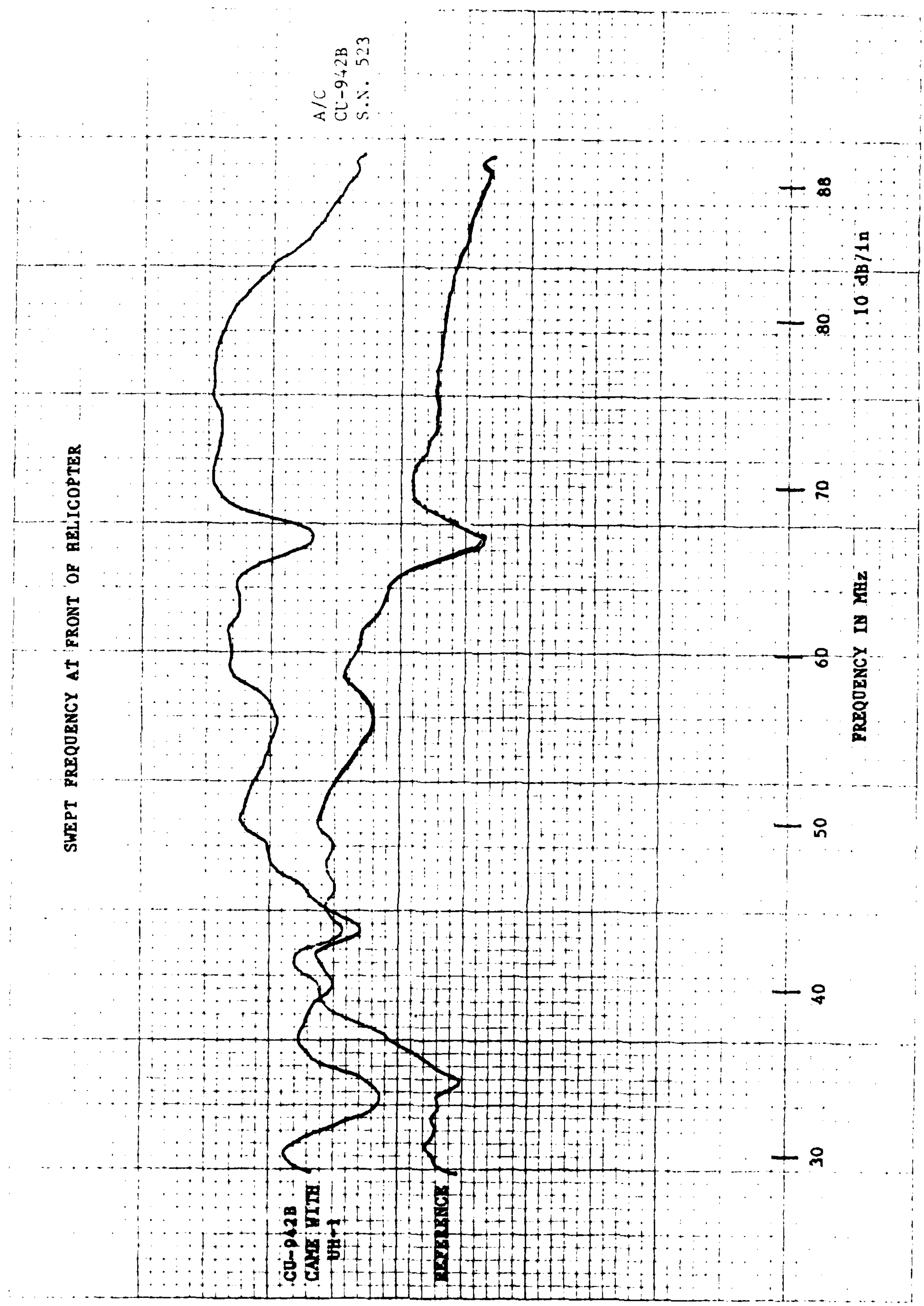


SWEPT FREQUENCY AT FRONT OF HELICOPTER
AV-1011/ PMI-22-7
AV-1011 GRAPHITE
REFERENCE
30
40
50
60
70
80
88
FREQUENCY IN MHz
10 dB/in


SWEPT FREQUENCY AT FRONT OF HELICOPTER
AV-1011 STANDARD
AV-1011/ STANDARD
REFERENCE
30
40
50
60
70
80
88
FREQUENCY IN MHz
10 dB/in


SWEPT FREQUENCY AT FRONT OF HELICOPTER
AV-401B
AV11-401B
REFERENCE
30
40
50
60
70
80
88
FREQUENCY IN MHz
10 dB/in


SWEPT FREQUENCY AT FRONT OF HELICOPTER
CU-942B
A/C WHIP
CU-942B
WITH A/C
WHIP
REFERENCE
30
40
50
60
70
80
88
FREQUENCY IN MHz
10 dB/in



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APPENDIX F. VSWR PLOTS - 32-FOOT GROUND PLANE

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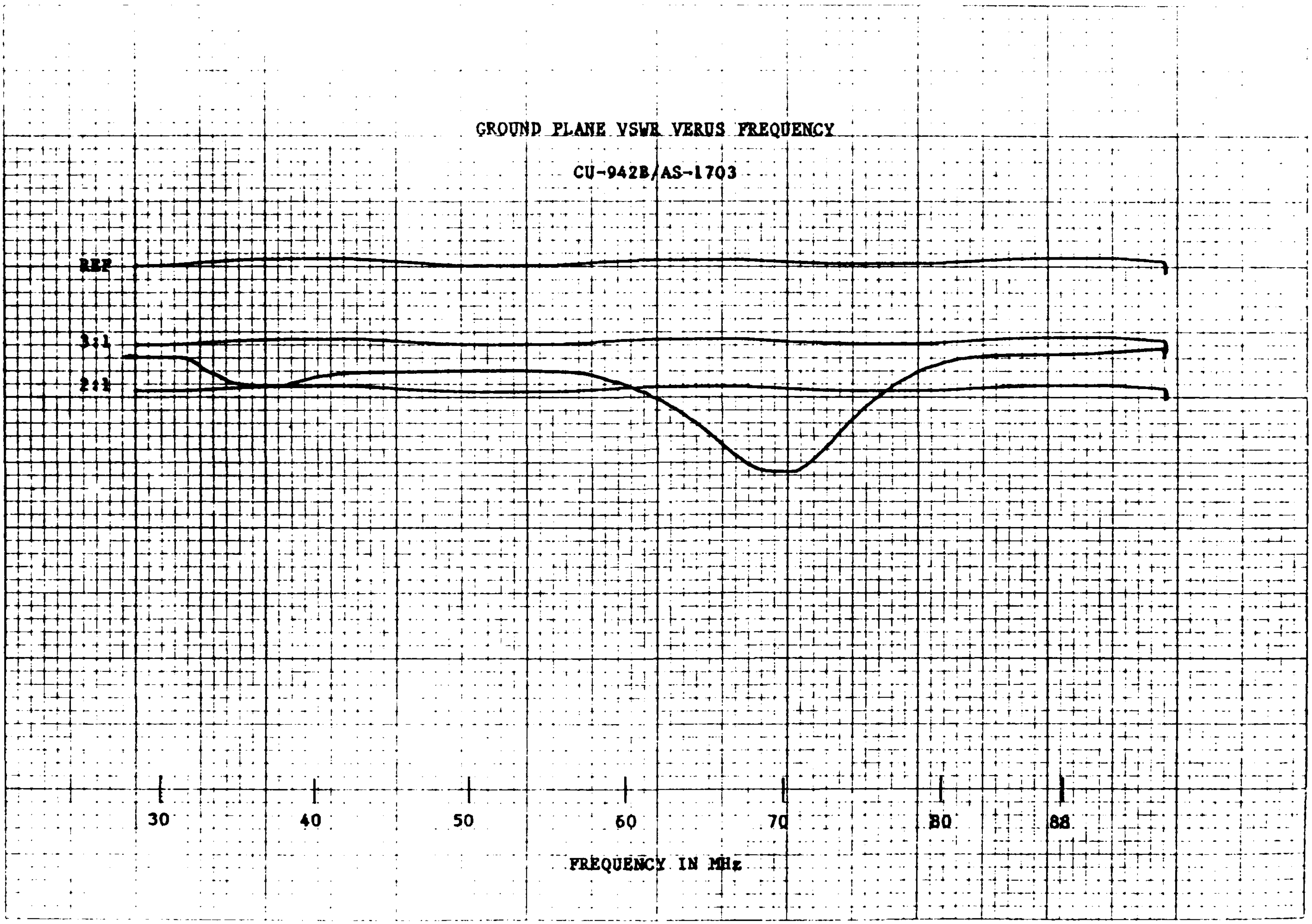
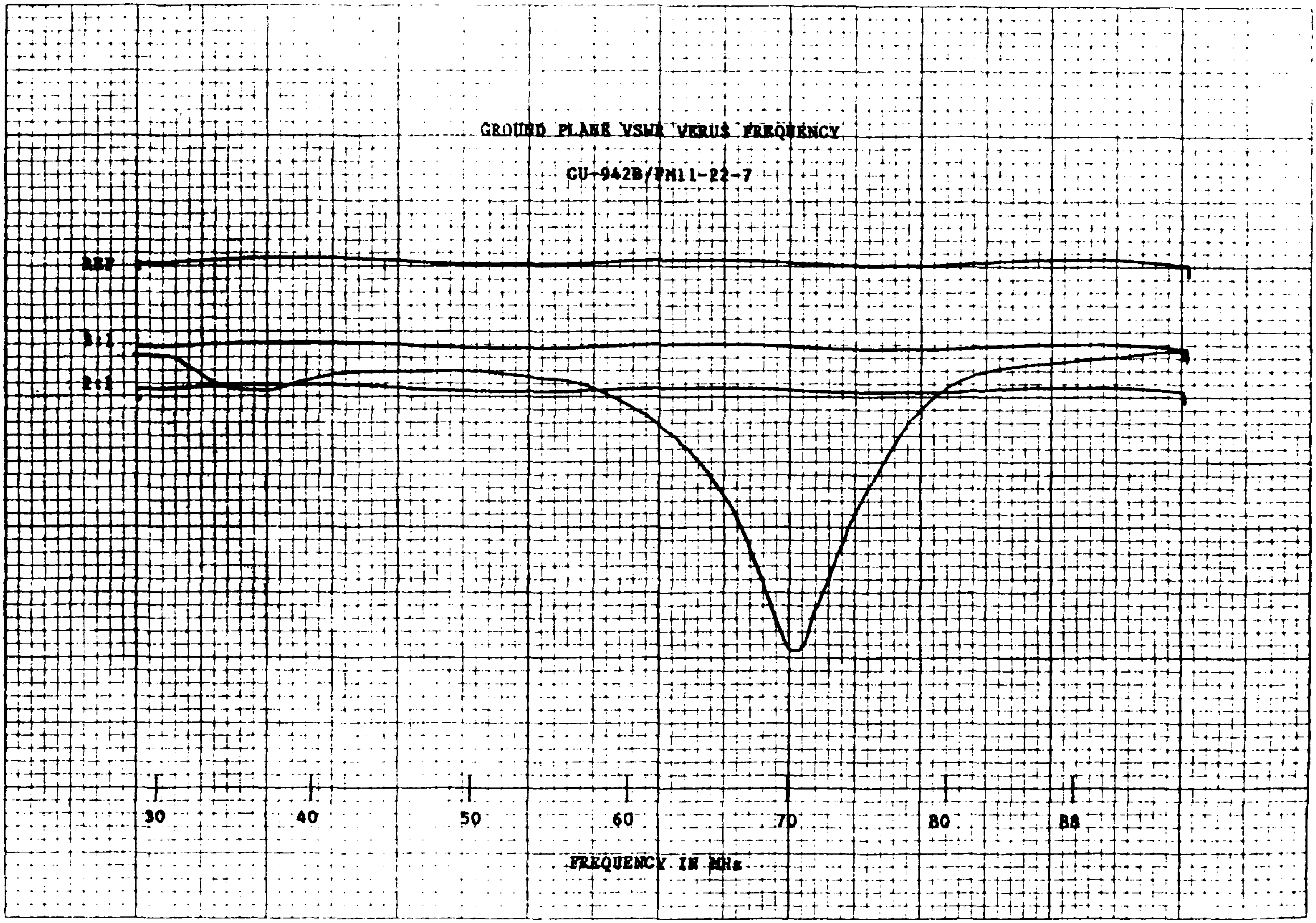
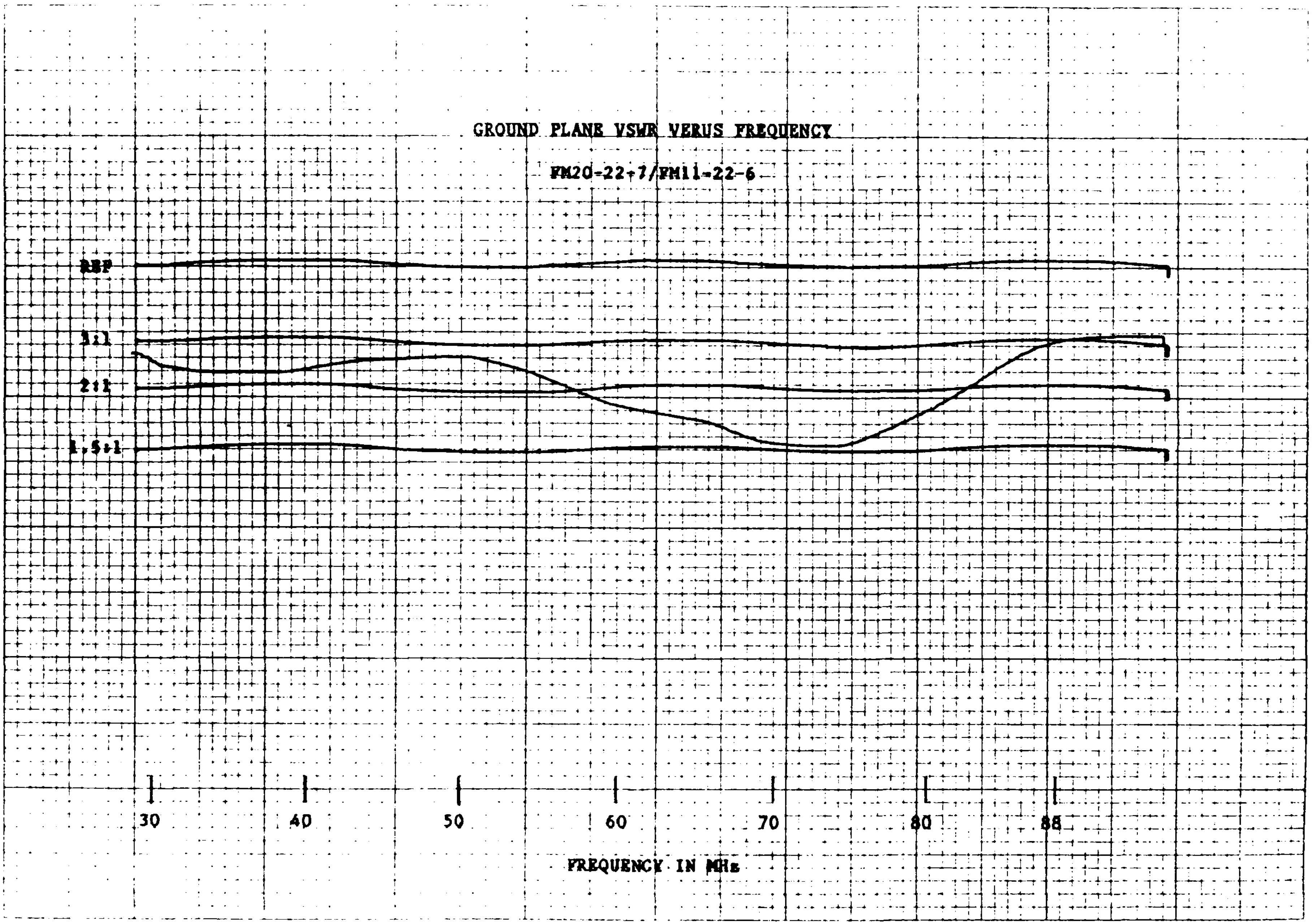
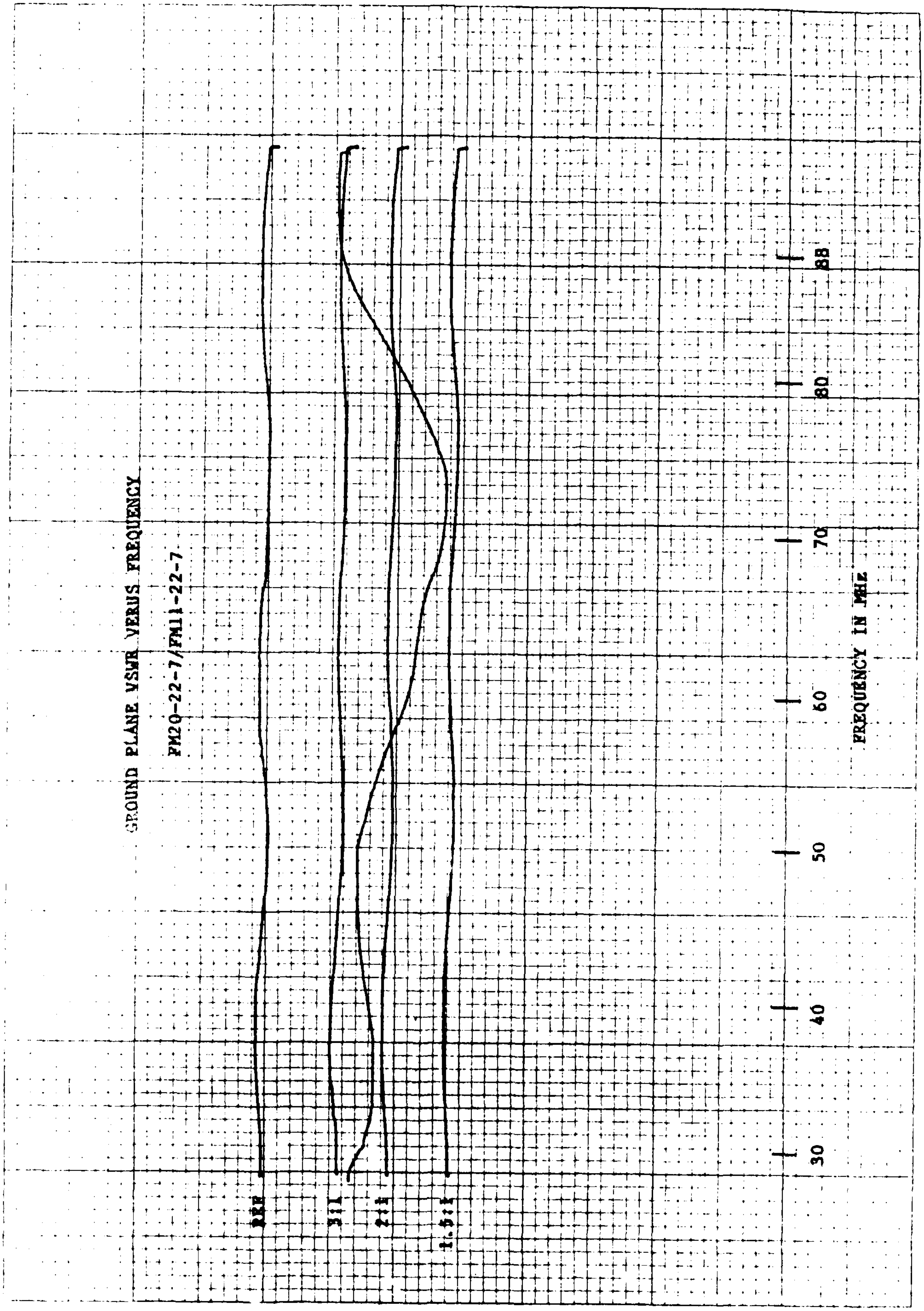
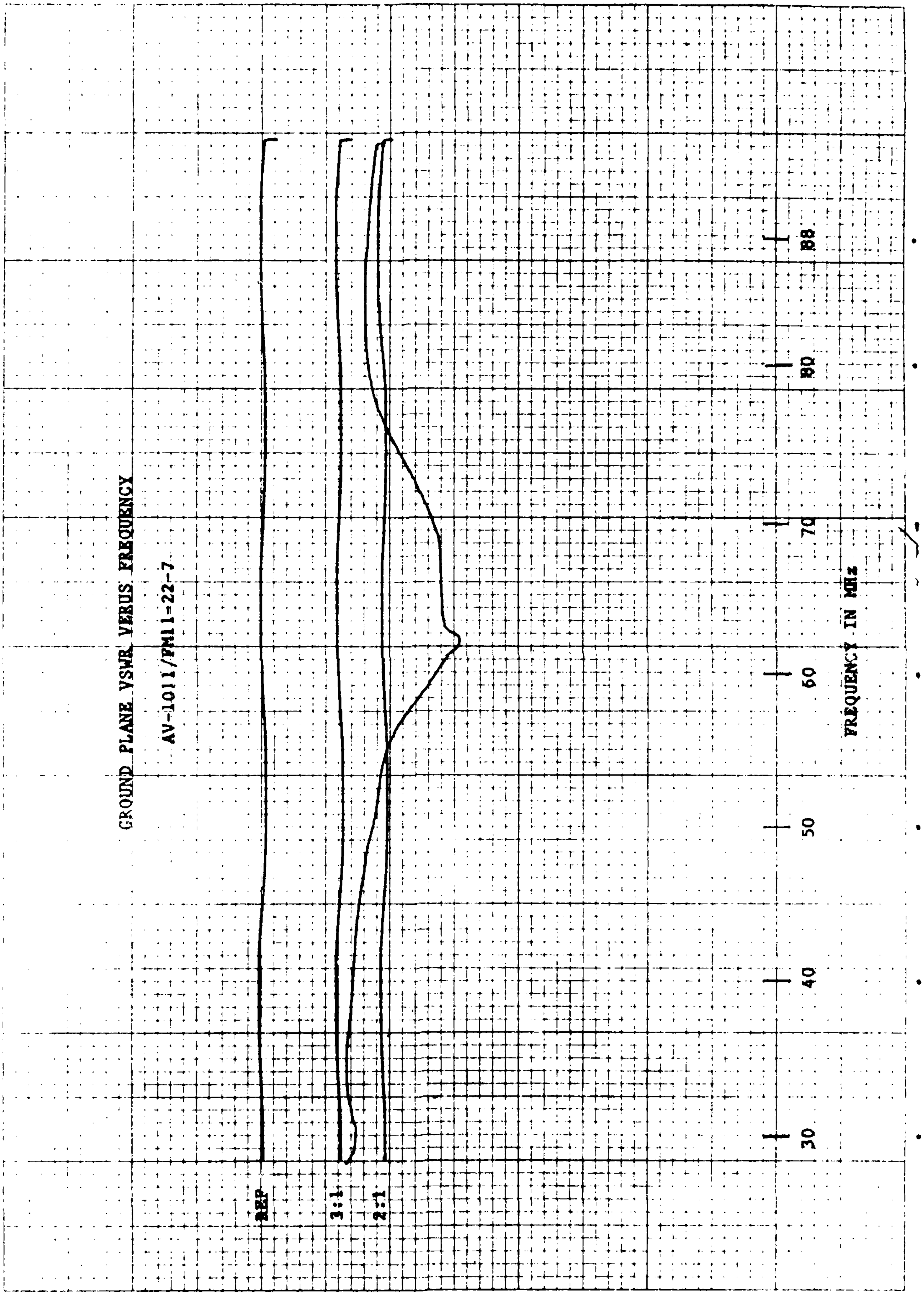
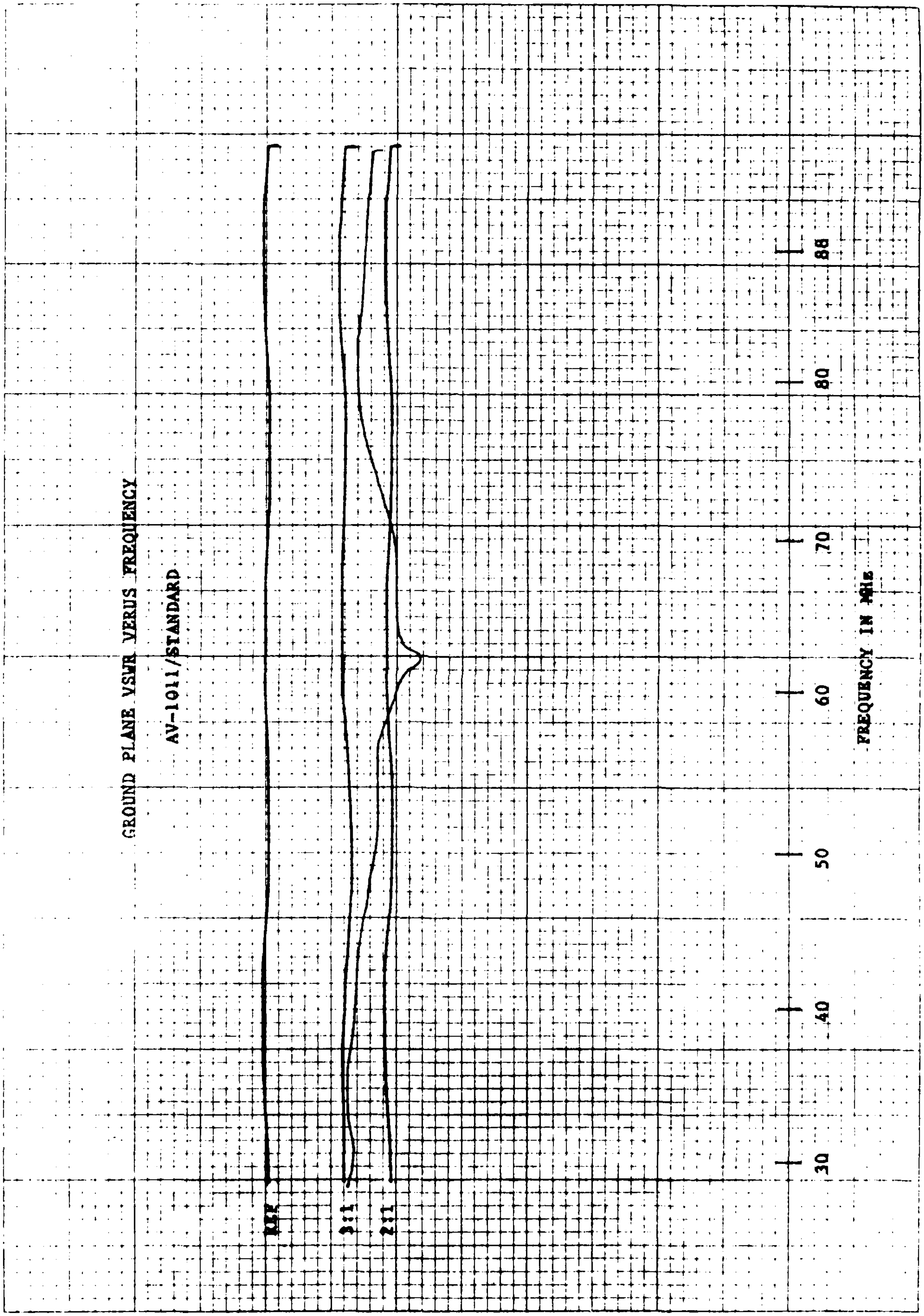

GROUND PLANE VSWR VERUS FREQUENCY
CU-942B/AS-1703
REF
3:1
2:1
30
40
50
60
70
80
88
FREQUENCY IN MHz

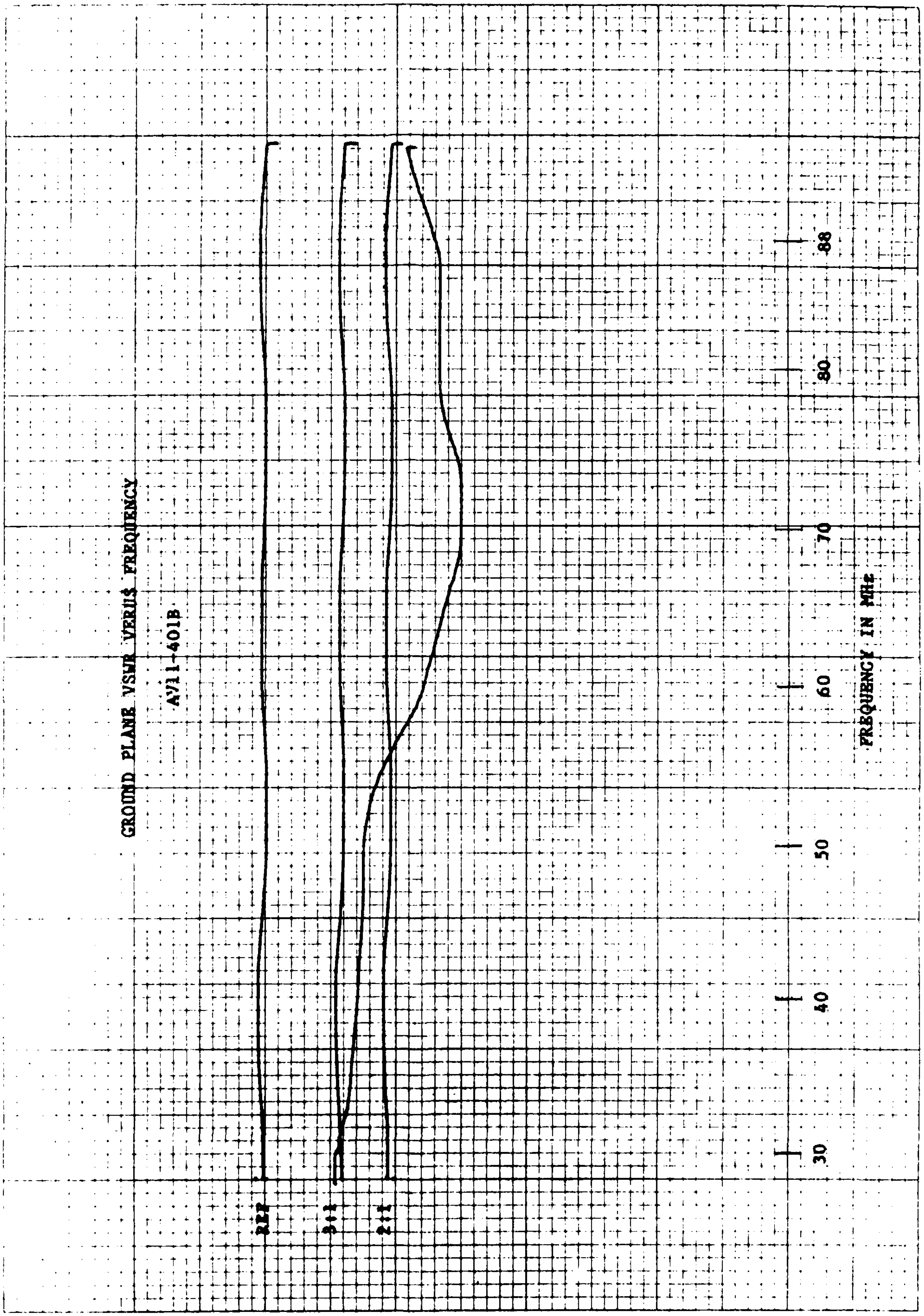

GROUND PLANE VSWR VERUS FREQUENCY
CU-942B/FM11-22-7
REF
3:1
2:1
30
40
50
60
70
80
88
FREQUENCY IN MHz


GROUND PLANE VSWR VERUS FREQUENCY
FM20-22-7/FM11-22-6
REF
3:1
2:1
1.5:1
30
40
50
60
70
80
88
FREQUENCY IN MHz


GROUND PLANE VSWR VERUS FREQUENCY
FM20-22-7/FM11-22-7
3:1
2:1
1.5:1
30
40
50
60
70
80
88
FREQUENCY IN MHz

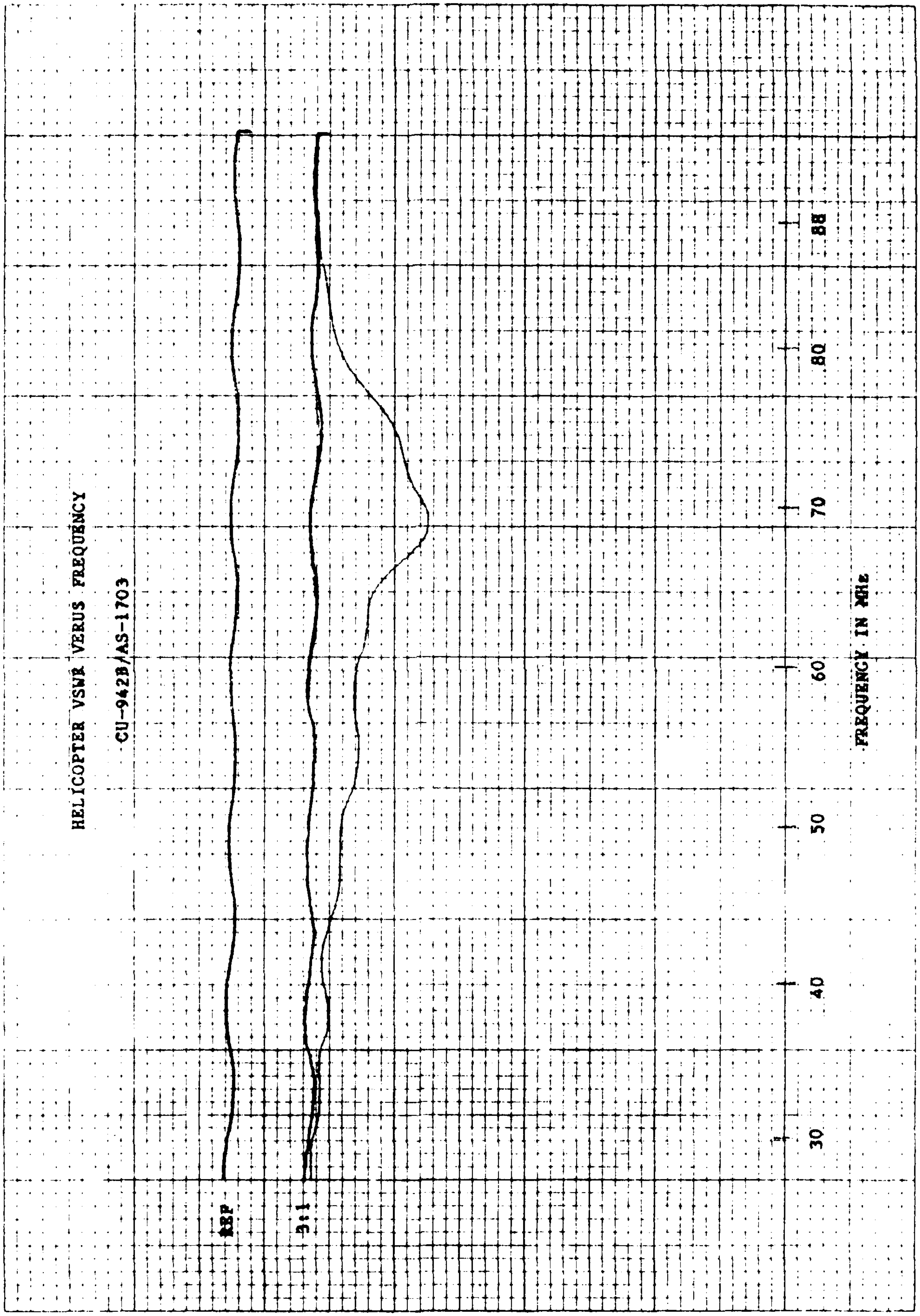

GROUND PLANE VSWR VERUS FREQUENCY
AV-1011/FM11-22-7
REF
3:1
2:1
30
40
50
60
70
80
88
FREQUENCY IN MHz

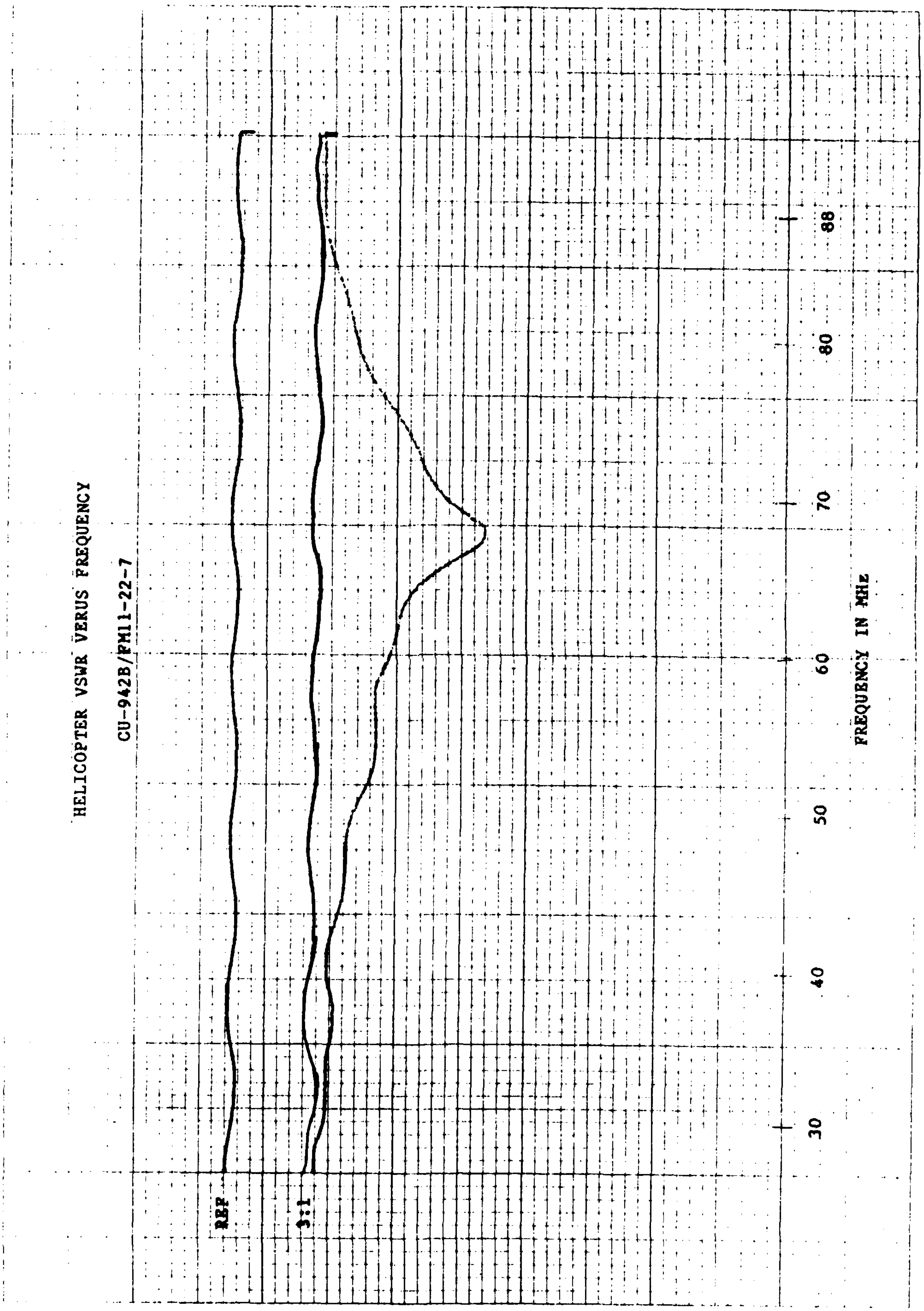

GROUND PLANE VSWR VERUS FREQUENCY
AV-1011/STANDARD
REF
3:1
2:1
30
40
50
60
70
80
88
FREQUENCY IN MHz

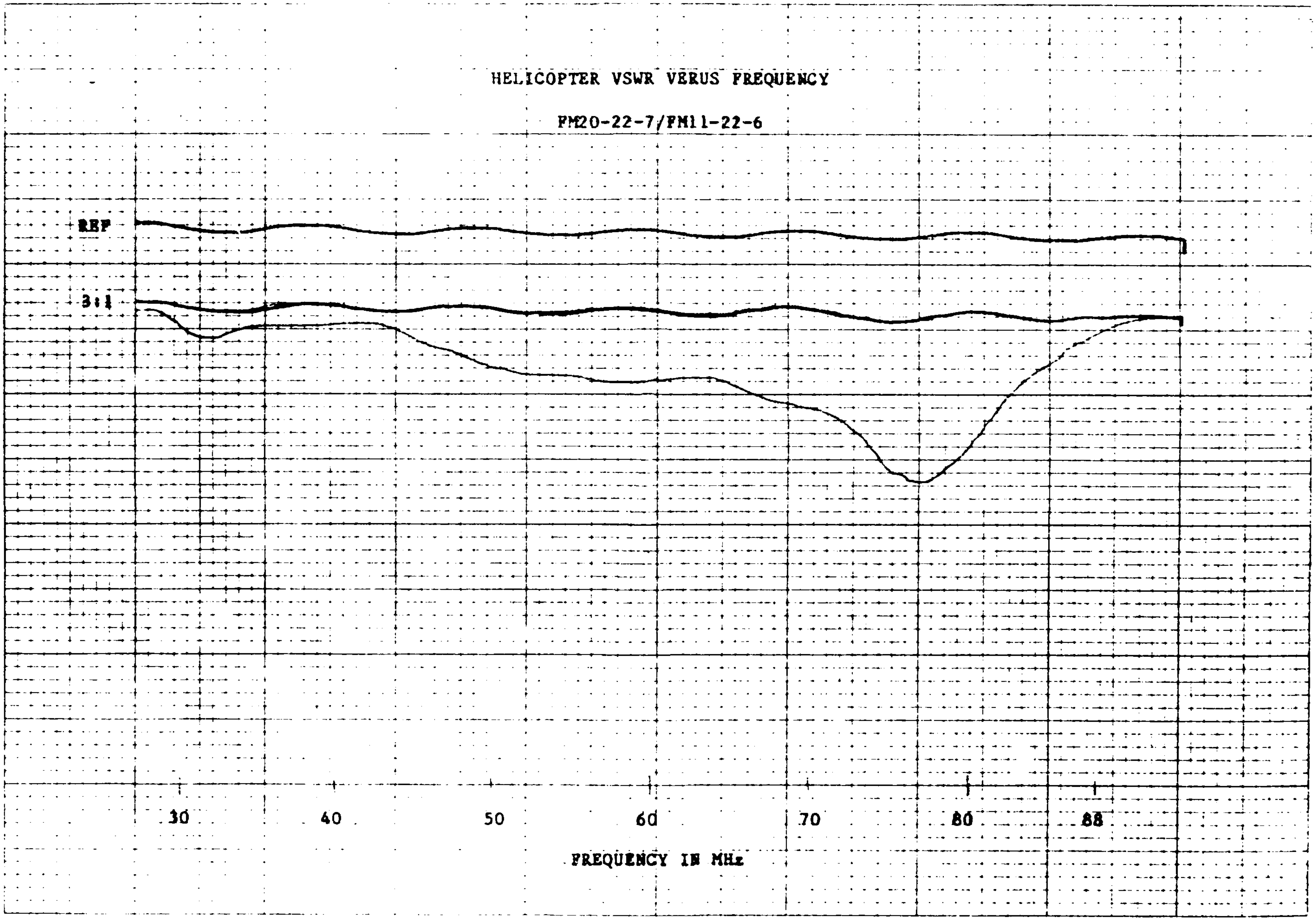


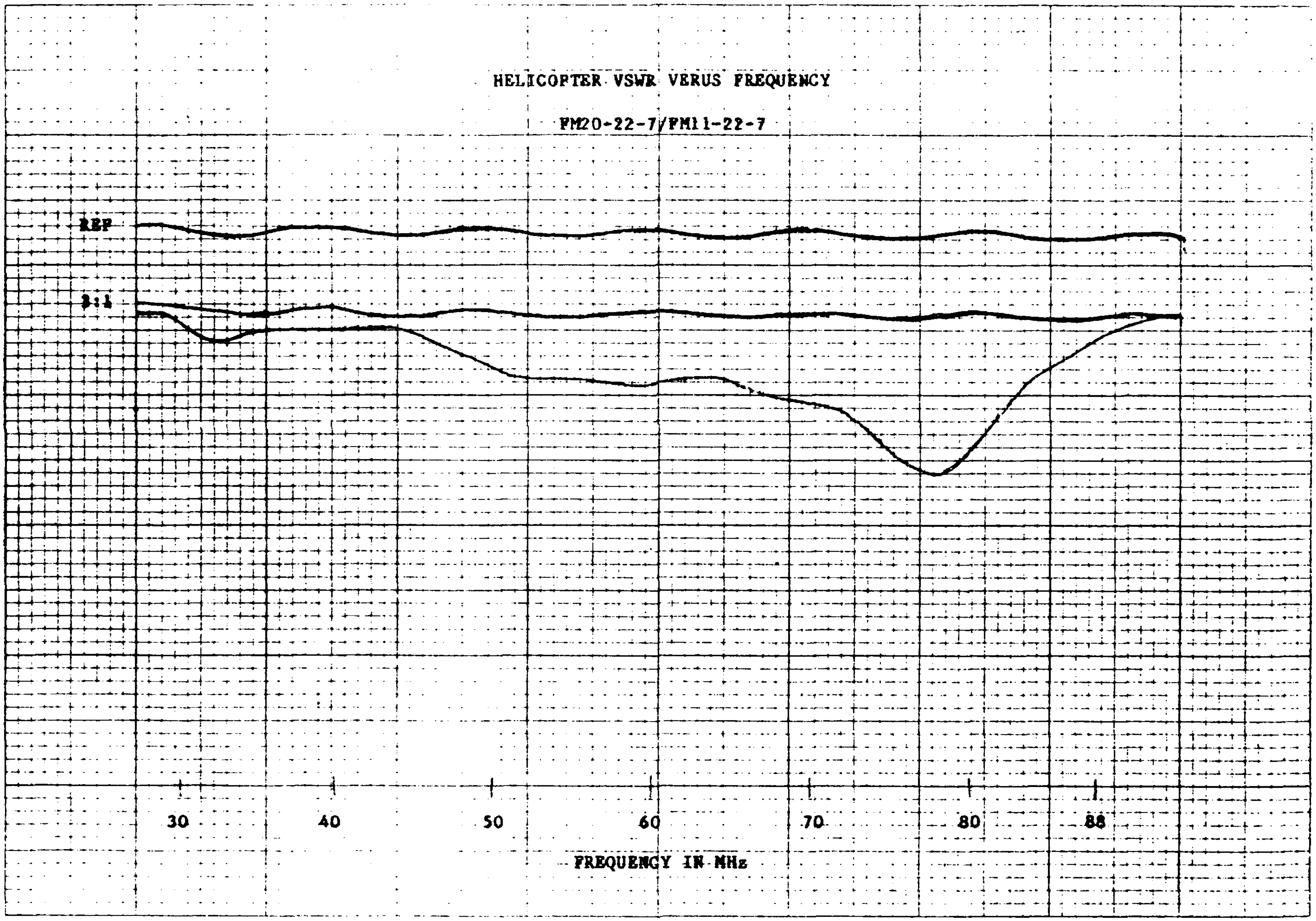
(page 92 is blank)

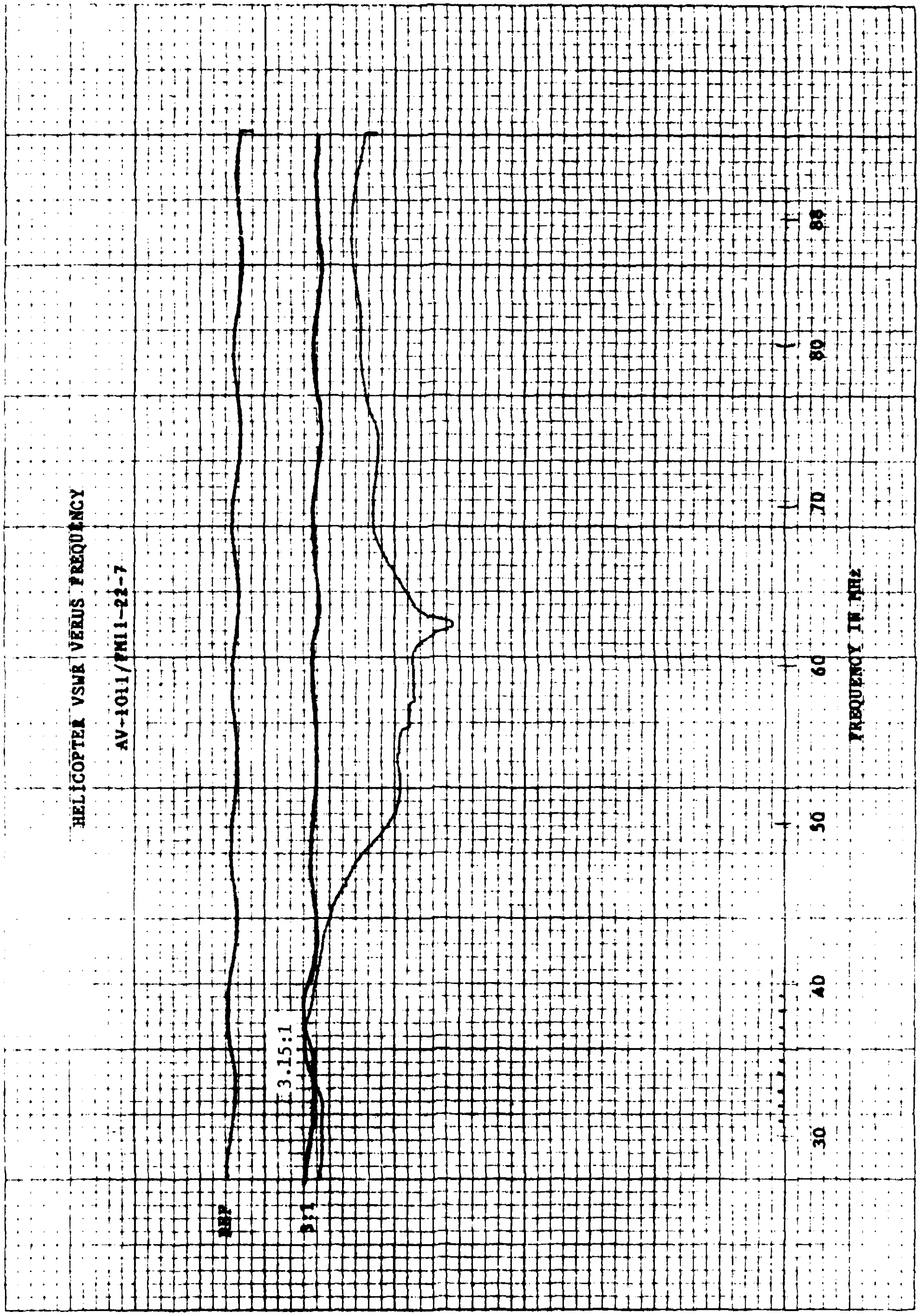
APPENDIX G. HELICOPTER VSWR PLOTS AT ANTENNA COUPLERS

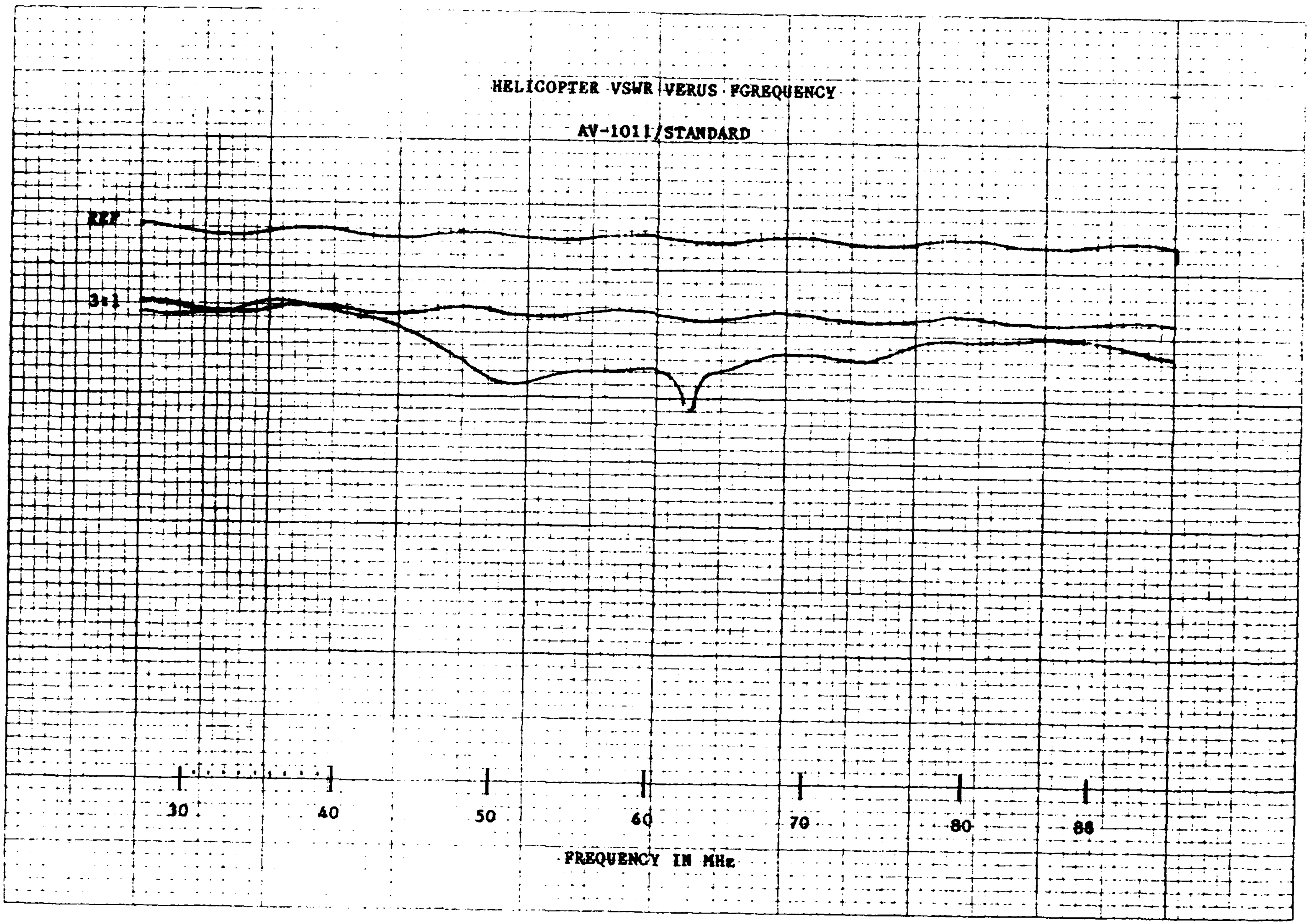

HELICOPTER VSWR VERUS FREQUENCY
CU-942B/AS-1703
RBP
3:1
30
40
50
60
70
80
88
FREQUENCY IN MHz

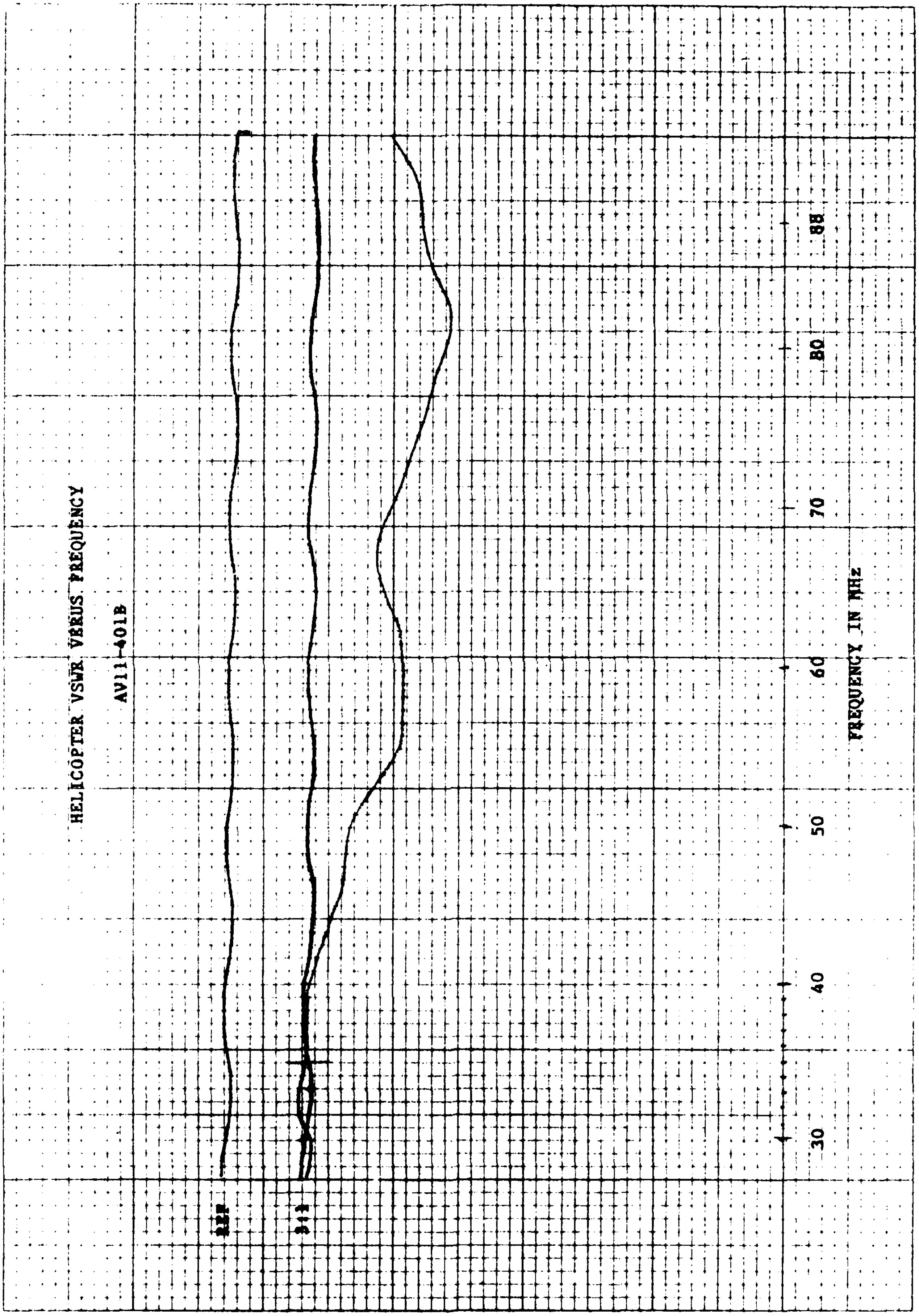

HELICOPTER VSWR VERUS FREQUENCY
CU-942B/FM11-22-7
REF
3:1
30
40
50
60
70
80
88
FREQUENCY IN MHz

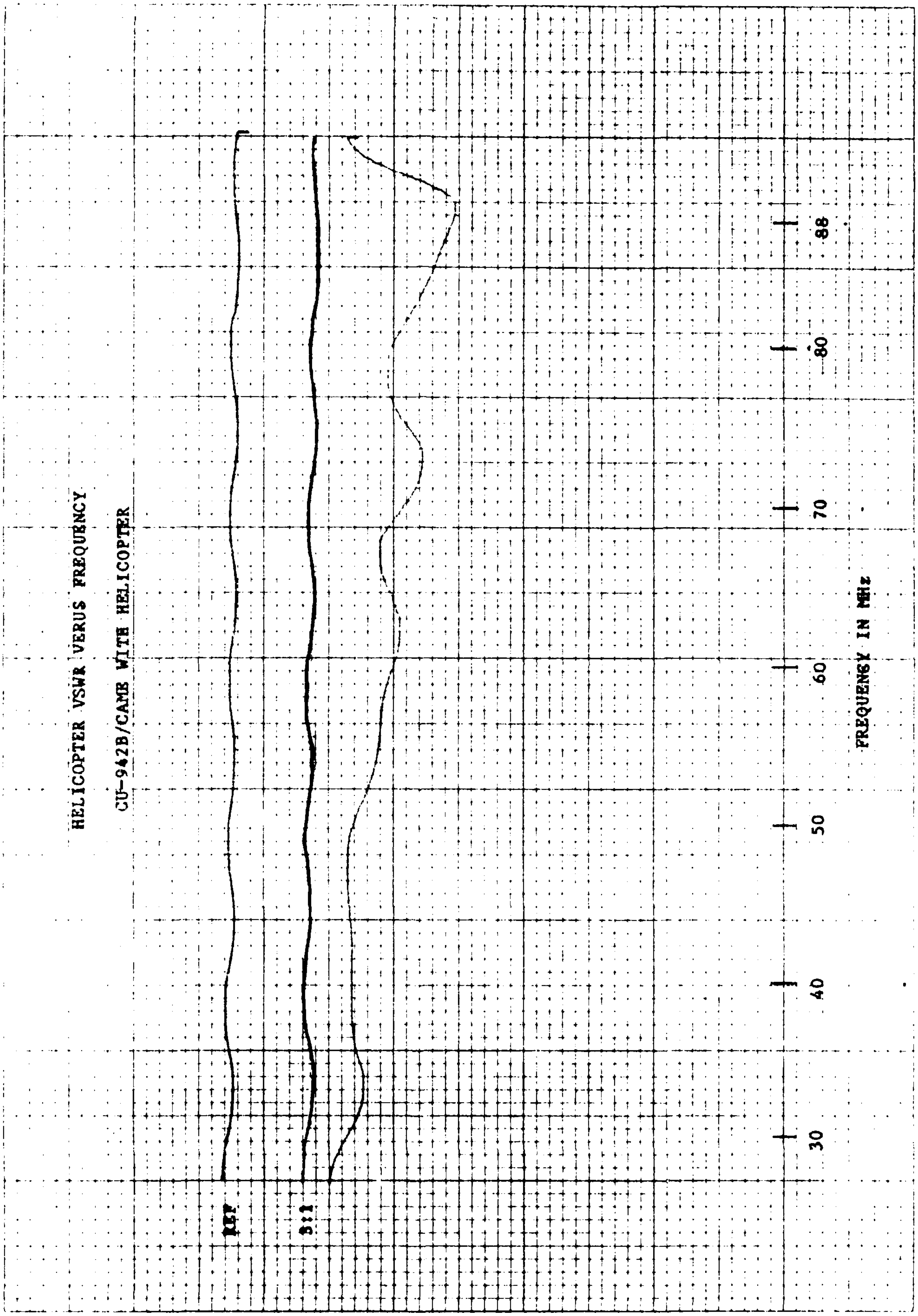

HELICOPTER VSWR VERUS FREQUENCY
FM20-22-7/FM11-22-6
REF
3:1
30
40
50
60
70
80
88
FREQUENCY IN MHz


HELICOPTER VSWR VERUS FREQUENCY
FM20-22-7/FM11-22-7
REF
3:1
30
40
50
60
70
80
88
FREQUENCY IN MHz


HELICOPTER VSWR VERUS FREQUENCY
AV-1011/FM11-22-7
REF
3:1
3.15:1
30
40
50
60
70
80
88
FREQUENCY IN MHz


HELICOPTER VSWR VERUS FGREQUENCY
AV-1011/STANDARD
REF
3:1
30
40
50
60
70
80
88
FREQUENCY IN MHz

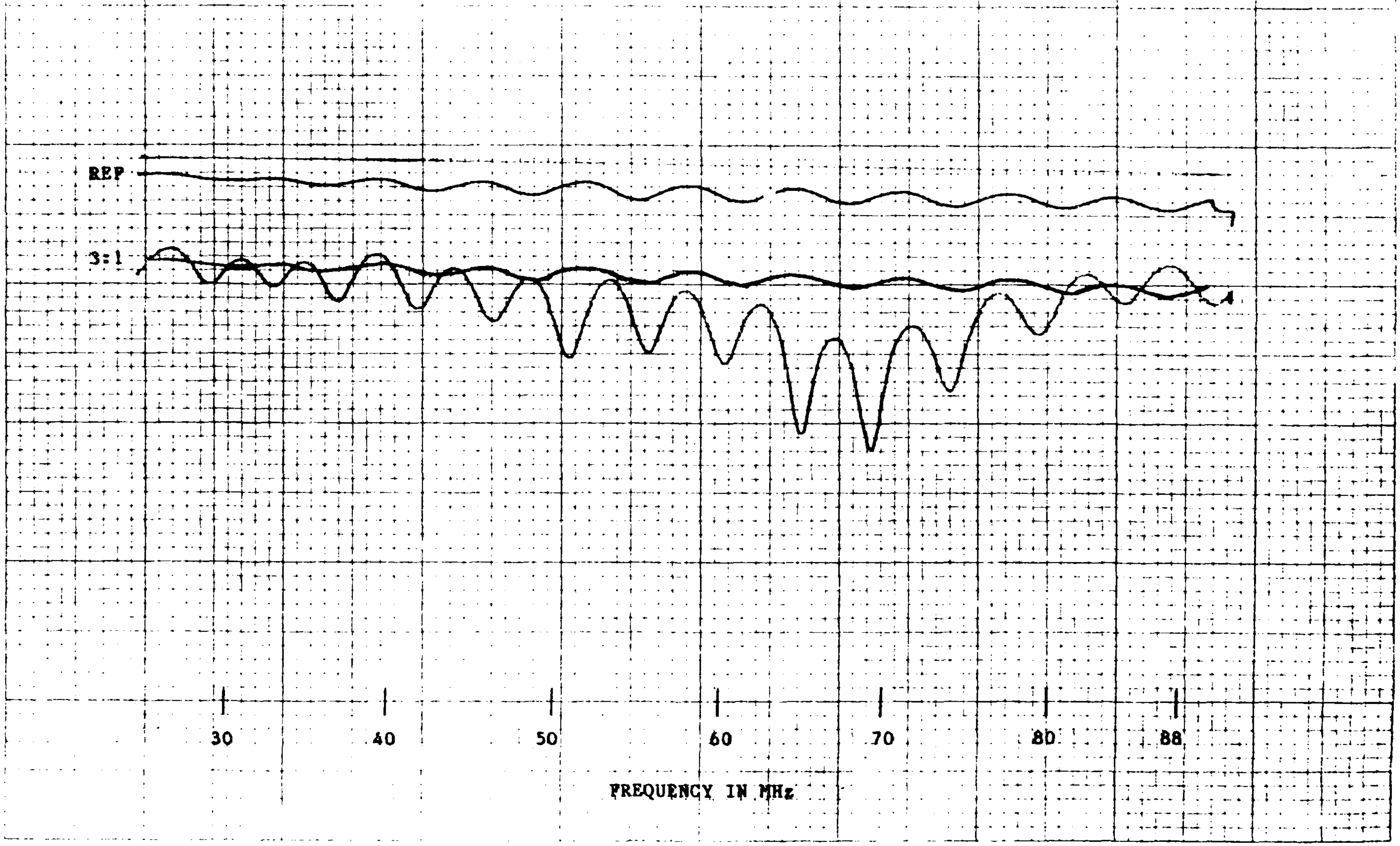

HELICOPTER VSWR VERUS FREQUENCY
AV11-401B
FREQUENCY IN MHz
30
40
50
60
70
80
88
REF
311


HELICOPTER VSWR VERUS FREQUENCY
CU-942B/CAME WITH HELICOPTER
REF
3:1
30
40
50
60
70
80
88
FREQUENCY IN MHz

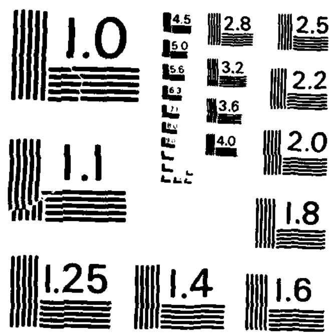
APPENDIX H. HELICOPTER VSWR PLOTS THROUGH TRANSMISSION CABLE

VSWR VERUS FREQUENCY THROUGH TRANSMISSION CABLE

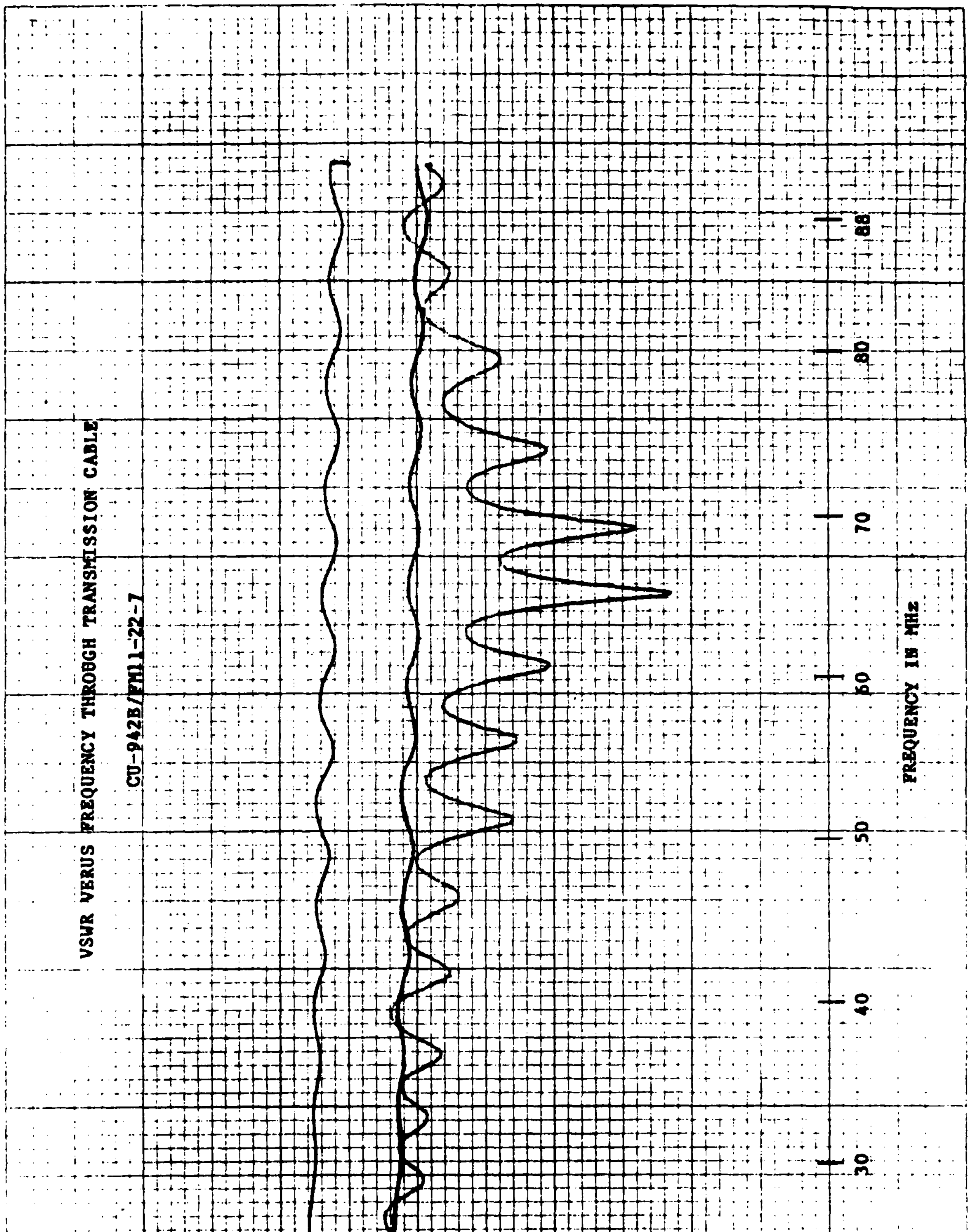
CU-942B/AS-1703

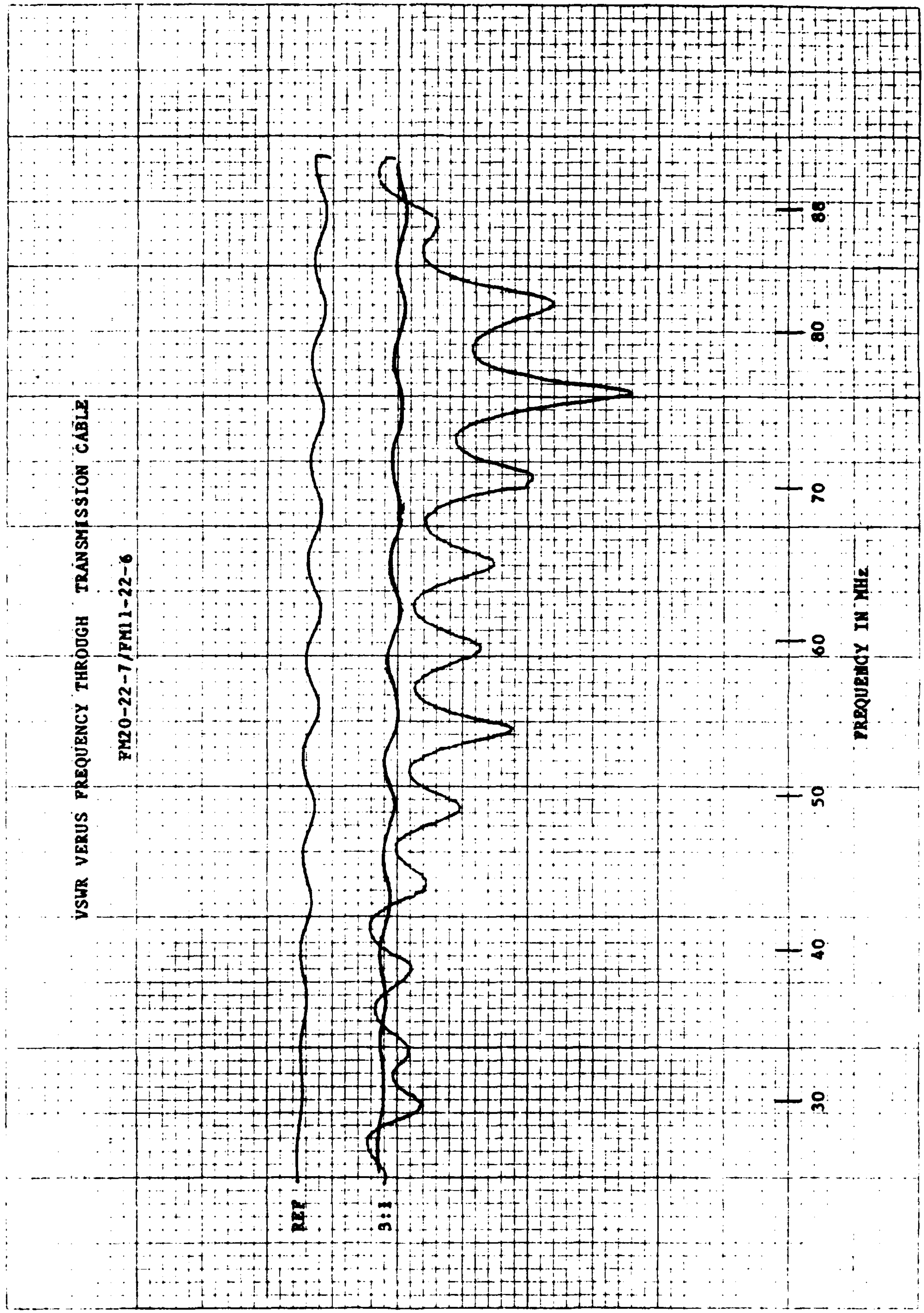


AD-A163 561 VHF-FM COMMUNICATIONS ANTENNAS FOR PROJECT SINCGARS 2/2
(UH-1 TAIL WHIP AND C.. (U) ARMY AVIATION SYSTEMS
COMMAND ST LOUIS MO J CARALYUS ET AL. DEC 85
UNCLASSIFIED USAAVSCOM-TR-85-E-3 F/G 17/2.1 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A


VSWR VERUS FREQUENCY THROUGH TRANSMISSION CABLE
CU-942B/FM11-22-7
REF
3:1
30
40
50
60
70
80
88
FREQUENCY IN MHz


VSWR VERUS FREQUENCY THROUGH TRANSMISSION CABLE
FM20-22-7/FM11-22-6
REF
3:1
30
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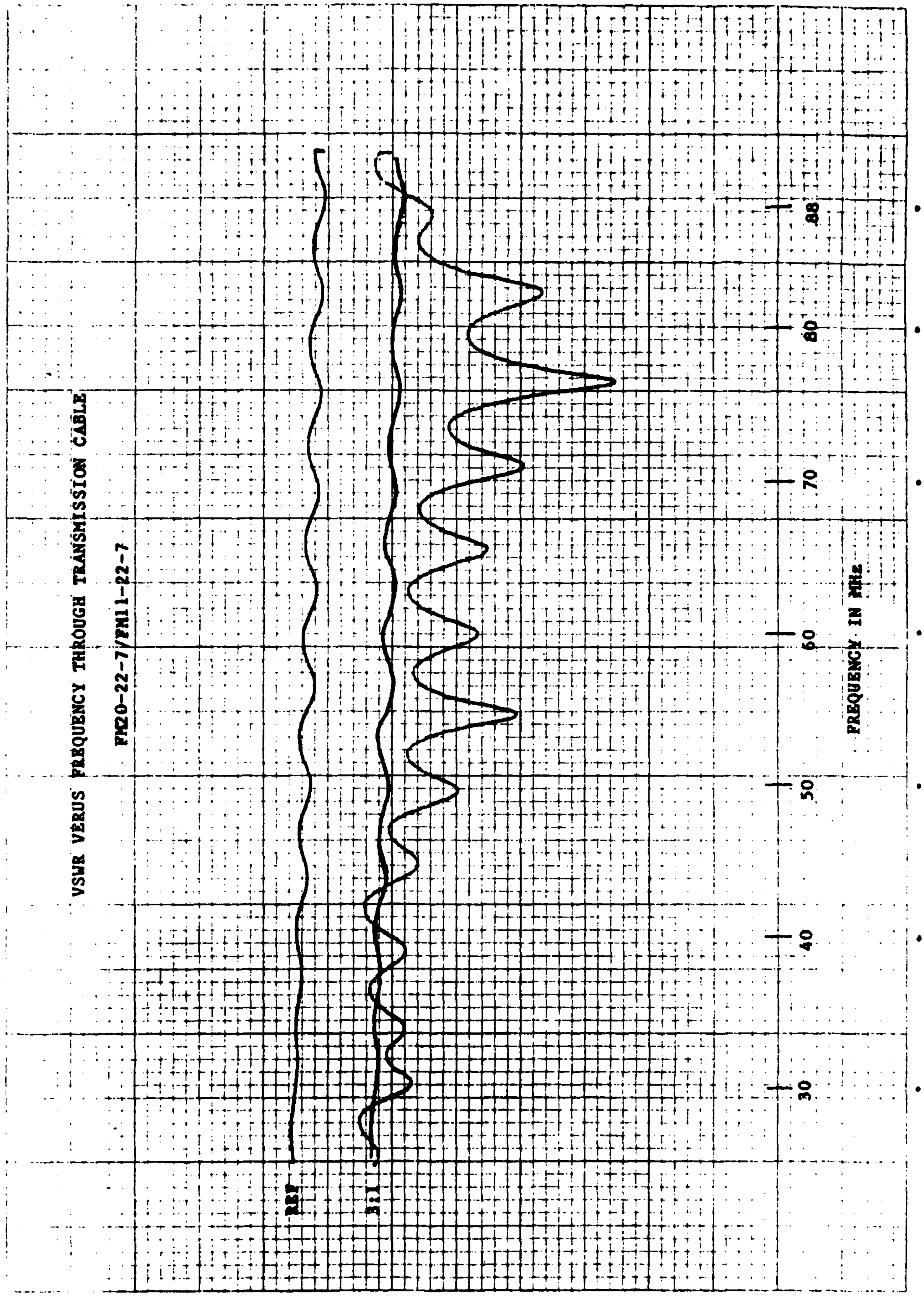
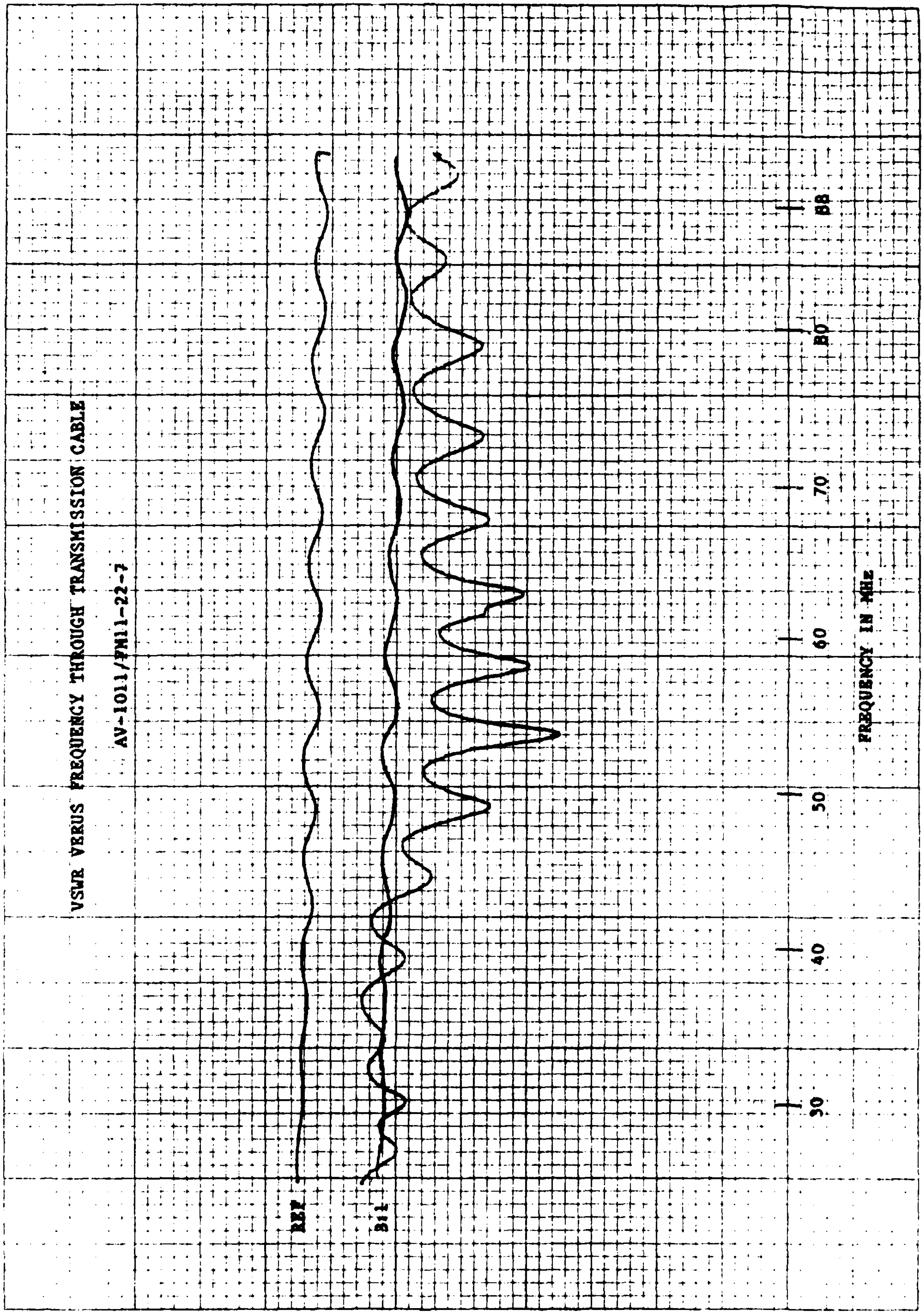
50
60
70
80
88
FREQUENCY IN MHz


VSWR VERUS FREQUENCY THROUGH TRANSMISSION CABLE
FM20-22-7/FM11-22-7
REF
1:1
30
40
50
60
70
80
88
FREQUENCY IN MHz


VSWR VERUS FREQUENCY THROUGH TRANSMISSION CABLE
AV-1011/FM11-22-7
REF
30
40
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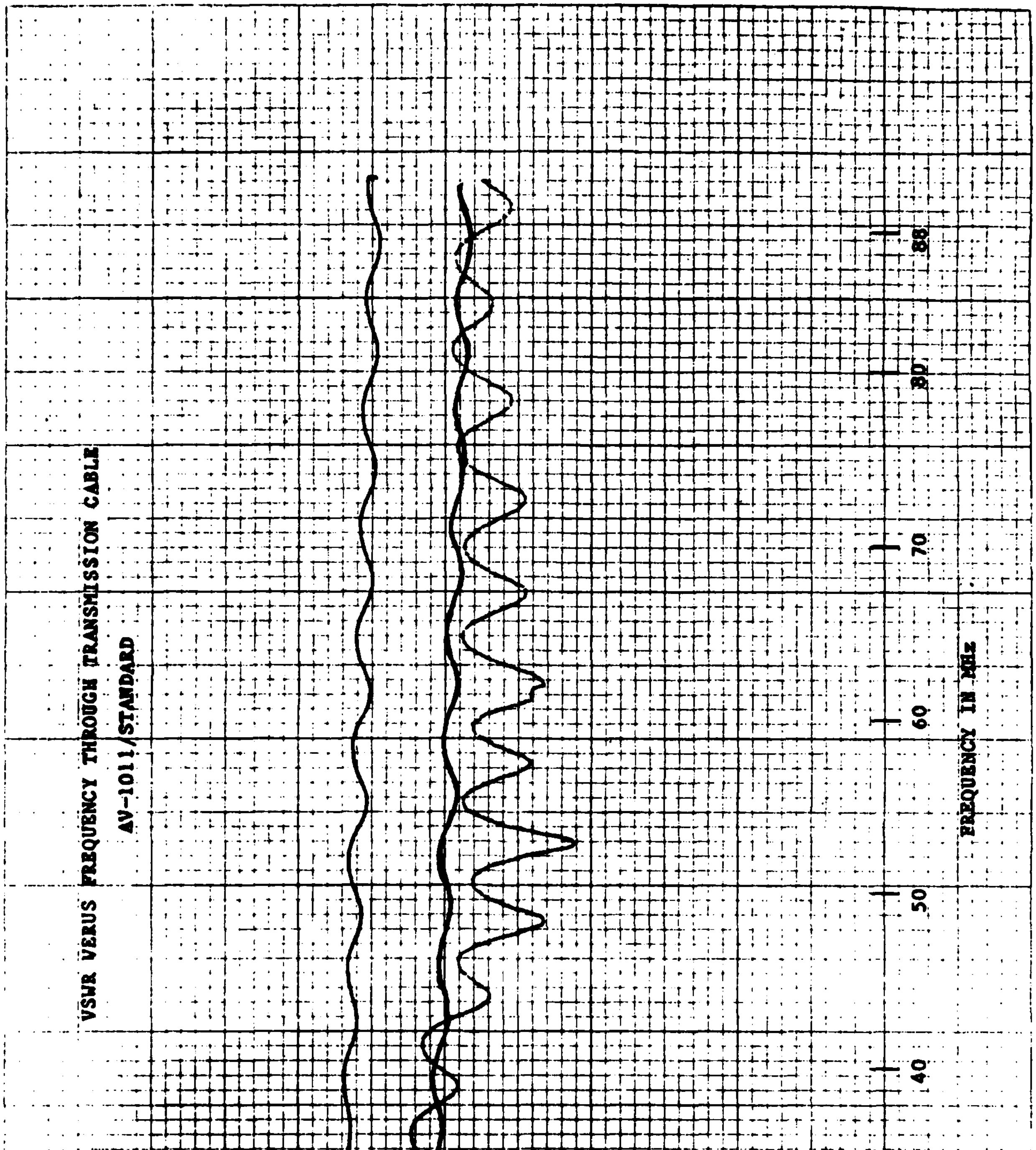
60
70
80
88
FREQUENCY IN MHz


VSWR VERUS FREQUENCY THROUGH TRANSMISSION CABLE
AV-1011/STANDARD
1:1
30
40
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60
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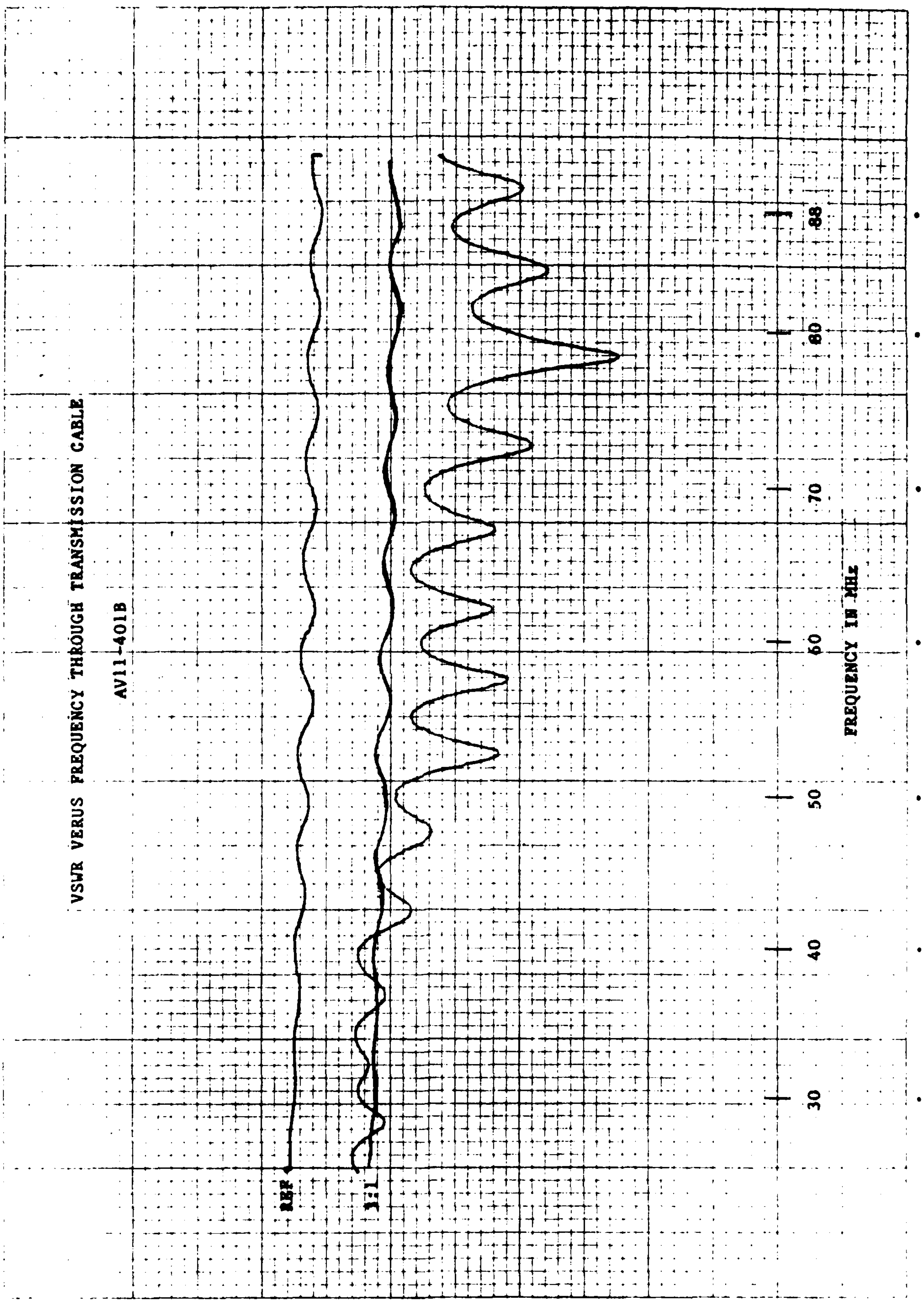
80
88
FREQUENCY IN MHz


VSWR VERUS FREQUENCY THROUGH TRANSMISSION CABLE
AV11-401B
REF
1:1
30
40
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60
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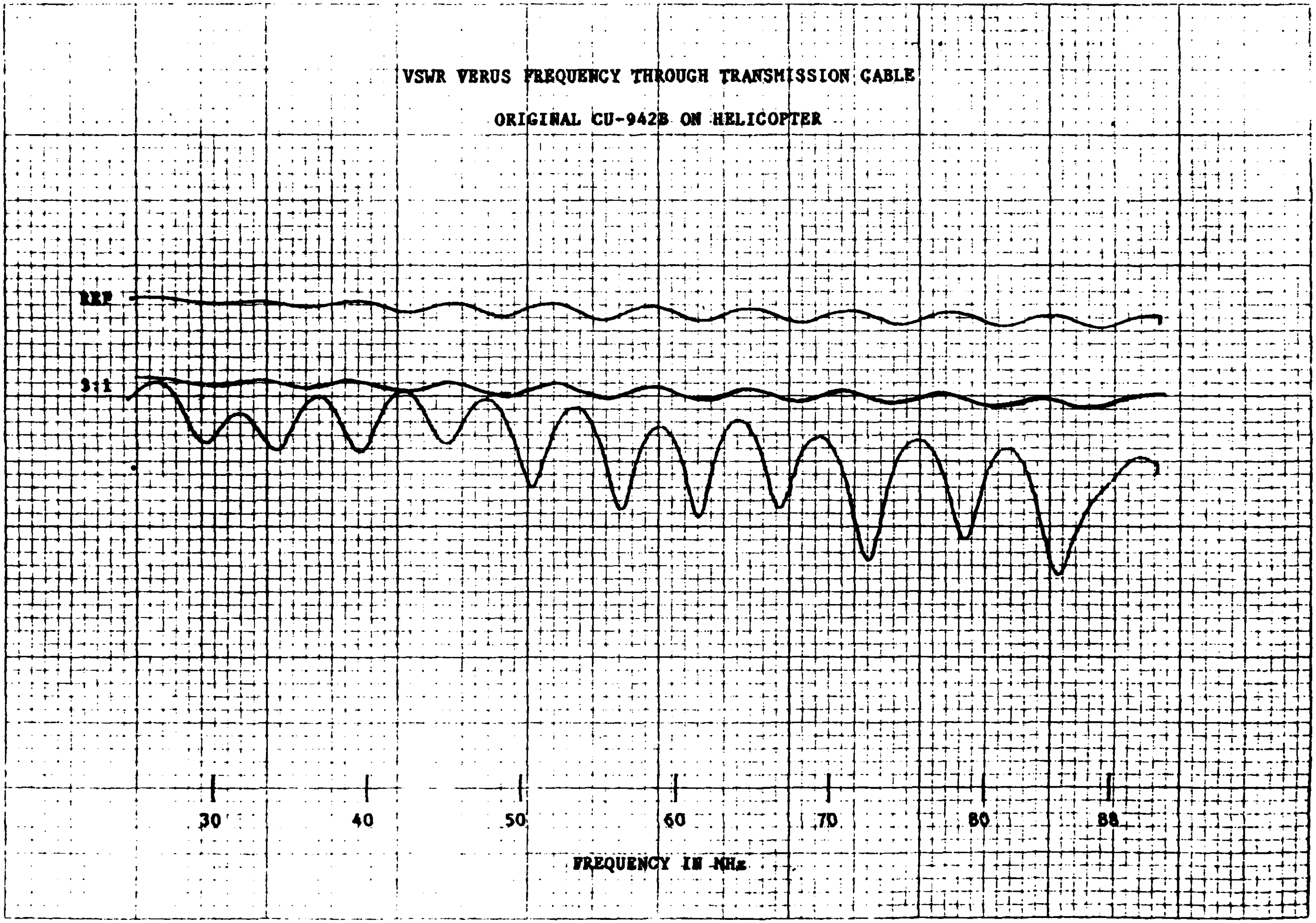
80
88
FREQUENCY IN MHz


VSWR VERUS FREQUENCY THROUGH TRANSMISSION CABLE
ORIGINAL CU-942B ON HELICOPTER
REF
3:1
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80
88
FREQUENCY IN MHz

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